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The Engineer

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PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—

1. AXLES for RAILWAY CARRIAGES and WAGONS.
2. AXLE-BOXES for RAILWAY CARRIAGES and WAGONS.
3. WHEELS and AXLES for RAILWAY CARRIAGES and WAGONS.
4. DRAGLINE EXCAVATORS.
5. OIL TANK WAGONS, RAILWAY.

Tenders due on the 19th May, 1925, for Nos. 1 to 3, and on the 26th May, 1925, for Nos. 4 and 5. Tender forms obtainable from above. 9146

Assistant Engineer REQUIRED by the GOVERNMENT of HONG KONG for the PUBLIC WORKS DEPARTMENT for 3 years' service, with possible permanency. Salary £460, rising to £500 a year by annual increments of £20, and thence (if appointment is made permanent) to £1000 a year, payable locally in dollars at the Government rate of exchange, which is at present fixed at 2s. to the dollar. In addition a strictly temporary exchange allowance of 20 per cent. of salary is at present paid, and thus at the present time the annual salary in dollars will be 5520 dollars a year. The current rate of exchange being now about 2s. 4d. to the dollar, the sterling equivalent of 5520 dollars is accordingly about £660. Travelling allowance at the rate of 240 dollars a year. No income tax payable. Free passages. Candidates, preferably unmarried, 24-30 years of age, must be regularly trained civil engineers and have passed the Institution of Civil Engineers' examination or have obtained exemption therefrom by an exempting degree. Must be good draughtsmen, proficient in land surveying and levelling. Should preferably have had experience in maintenance work of waterworks of a large town and some experience in waterworks construction.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W.1, quoting M/13,411. 9149

Sanitary Engineer REQUIRED by the GOVERNMENT of the TANGANYIKA TERRITORY for the PUBLIC WORKS DEPARTMENT. Salary, £780, rising to £800 a year by annual increments of £25, to be engaged in the first instance for a tour of 20-30 months' service, with prospect of the appointment becoming permanent after two tours of service, if re-engaged for the second. Free quarters and passages and liberal leave on full salary. Candidates, not over 40 years of age, must be Associate Members of the Institution of Civil Engineers or hold equivalent professional qualifications, and have had at least 5 years' experience in the actual charge of the Construction and Maintenance of Water and Sewage Works. Must be fully conversant with the latest methods of Mechanical Filtration and be capable of Carrying Out Detailed Plans and Estimates in connection with Water Supply and Sewage Schemes, both Gravitation and Pumping.—Apply at once by letter, stating age and giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W.1, quoting M/13,449. 9139

Technical Assistant REQUIRED for writing technical descriptive matter and instructional handbooks on aircraft, aero-engines and aircraft equipment. Applicants must have engineering knowledge and experience and a capacity for clear expression in good English. Some experience in writing for publication is desirable. Ex-Service man preferred. Commencing salary £250 a year plus Civil Service bonus (giving a present total of £377) on the scale £250-£450 a year plus bonus.—Apply, quoting A.62, to the SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 9114

Test Assistants with Technical training to the standard of B.Sc. Engineering Degree and works and drawing-office experience, REQUIRED in connection with airworthiness approval of aircraft. Experience in strength and aerodynamic calculations an advantage. Starting salary 60s. per week plus Civil Service bonus, giving a present total of 97s. 3d. Ex-Service men preferred.—Write, quoting A.60, to the SUPERINTENDENT, R.A.E., South Farnborough, Hants. 9116

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY.
UNIVERSITY OF MANCHESTER
(Faculty of Technology).
Principal: B. MOUAT JONES, D.S.O., M.A.

EDMUND MILLS HARWOOD MEMORIAL SCHOLARSHIP.

The Governing Body announce the offer of a Scholarship of the value of £50 per annum for three years, tenable in one of the University Engineering Courses in the College of Technology.

Forms of nomination and all information may be obtained on application to the REGISTRAR of the College.

Applications must be received on or before 15th June. 9130

Sunderland Education Committee.
THE TECHNICAL COLLEGE.
DEPARTMENT OF MECHANICAL ENGINEERING.

The Committee invite APPLICATIONS for the POSITION of HEAD of the MECHANICAL ENGINEERING DEPARTMENT. Applicants must possess an Honours Degree and have had good drawing-office and works experience.

The standard of the full-time day courses is that required for an Honours University Degree, and that of the part-time evening courses (T.4 to T.8) is suitable for senior and advanced students from the marine engineering drawing-offices and works of the district. Experience in all types of prime movers, steam and oil, is desirable. There are courses also in advanced structures, hydraulics, &c.

Present salary scale £500-£50-£600, less 5 per cent. voluntary abatement. This scale is subject to reconsideration in view of the Burnham Award, 1925.

Application forms can be obtained from the undersigned and should be returned not later than Monday, 18th May, 1925.

HERBERT REED,
Chief Education Officer.

Education Offices:
15, John-street, Sunderland,
22nd April, 1925. 9066

PUBLIC NOTICES

The University of Sheffield.
ASSISTANT LECTURESHIP IN CIVIL ENGINEERING.

The Council are about to APPOINT an ASSISTANT LECTURER in CIVIL ENGINEERING. Salary £300 per annum. Further particulars may be obtained from the undersigned, with whom applications should be lodged by the 22nd May.

W. M. GIBBONS,
9040 Registrar.

Administrative County of LONDON.
TWIN-SCREW STEAMSHIP.

The London County Council invites TENDERS for the CONSTRUCTION and DELIVERY of a TWIN-SCREW STEAMSHIP, about 260ft. long by 45ft. beam, with Machinery, &c., for the conveyance of 1500 tons of sewage sludge from the Outfall Works at Crossness and Barking Creek to the North Sea.

Persons desiring to submit Tenders may obtain, on and after Monday, the 11th May, 1925, the drawings, specification, form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W.1, upon payment of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the vessel may be obtained on personal application, and the drawings, specification, and other contract documents may be inspected at the Old County Hall before payment of the fee.

No Tender received after 4 p.m. on Monday, the 8th June, 1925, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
9106 Clerk of the London County Council.

City of Chichester.
SUPPLY OF APPROXIMATELY FIVE MILES OF 12in. DIAMETER CAST IRON WATER MAINS.

The Town Council of the City of Chichester invite TENDERS for the SUPPLY of nearly FIVE MILES of CAST IRON WATER MAINS and SPECIAL PIPES. Specification and quantities can be obtained from the City Engineer, Frank J. Lobley, A.M. Inst. C.E., upon payment of a deposit of Three Guineas, which will be returned on receipt of a bona fide Tender or return of the papers. Other details can be seen at his office, North-street, Chichester, during office hours. Sealed Tenders, endorsed "Tender for Water Mains," to be delivered at my office not later than Saturday, the 30th day of May, 1925.

The Council do not bind themselves to accept the lowest or any Tender.

J. W. LOADER COOPER,
Town Clerk.

Chichester,
4th May, 1925. 9132

City of Wakefield Waterworks.
CONTRACT FOR MECHANICAL FILTRATION PLANT.

The Waterworks Committee is prepared to receive TENDERS for the SUPPLY and ERECTION of MECHANICAL FILTRATION PLANT, to deal with Two Million Six Hundred Thousand Gallons per day.

Specification, conditions of contract, form of Tender and other particulars can be obtained from Mr. C. Clemesha Smith, M. Inst. C.E., Waterworks Engineer, Town Hall, Wakefield, on and after Friday, 15th May, 1925, on payment of a deposit of Five Guineas, which will be returned on receipt of a bona fide Tender and the documents supplied.

Tenders, endorsed "Tender for Mechanical Filters," to be delivered to me not later than Twelve o'clock Noon on Monday, 8th June, 1925.

A. C. ALLIBONE,
Town Clerk.

Town Hall, Wakefield. 9143

PUBLIC NOTICES

City of Liverpool.
The Corporation are prepared to receive TENDERS for the SUPPLY and DELIVERY of various classes of TRAMWAY MATERIAL, as under—
Schedule No. 1.—STEEL TRAMWAY RAILS.
Schedule No. 2.—STEEL TRAMWAY RAIL FISH-PLATES.
Schedule No. 3.—STEEL FISH BOLTS.
Schedule No. 4.—STEEL TIE-BARS.
Schedule No. 5.—COPPER BONDS.

Firms are required to state clearly, when making application for the necessary Tender forms, the name and number of the schedule for which they desire to be furnished with Tender form.

Duplicate forms of Tender for record purposes will NOT be supplied.

Tender forms will be forwarded UPON RECEIPT OF APPLICATION IN WRITING to—
The City Engineer,
Municipal Buildings, Dale-street,
Liverpool.

Tenders must be sealed and enclosed in the official envelopes provided, endorsed in accordance with the instructions given on the form of Tender, and FORWARDED THROUGH THE POST, addressed to
The Town Clerk,
Municipal Buildings,
Liverpool.

LATEST TIME AND DATE FOR RECEIPT OF TENDERS—TEN O'CLOCK A.M. ON FRIDAY, THE 22nd MAY, 1925.

WALTER MOON,
Town Clerk.

29th April, 1925. 9133

City of Nottingham.
WATER DEPARTMENT.
TEST PUMPING, BURTON JOYCE.

The Water Committee invite TENDERS from competent contractors for PROVIDING the necessary PLANT for TESTING the YIELD of WATER from Three Bore-holes at the Burton Joyce Pumping Station, situate in Shaftesbury-avenue, Burton Joyce, Notts.

General conditions, specification, schedule and form of Tender may be obtained from Mr. F. W. Davies, Engineer and General Manager, Water Offices, Castle Boulevard, Nottingham, on payment of a deposit of £2 2s., which will be refunded on receipt of a bona fide Tender not afterwards withdrawn, and the return of all documents.

Tenders must be endorsed "Tender for Test Pumping at Burton Joyce," and reach the undersigned not later than the 25th day of May, 1925.

The Corporation do not bind themselves to accept the lowest or any Tender.

W. J. BOARD, O.B.E.,
Town Clerk.

Guildhall, Nottingham,
2nd May, 1925. 9086

The Great Indian Peninsula RAILWAY COMPANY, 48, Copthall-avenue, London, E.C. 2, invite TENDERS for—

1. LAMP GLASSES, &c.	Fee	7s. 6d.
2. LAMPS and FITTINGS	,,	5s.
3. LOCOMOTIVE BOILERS	,,	£1
4. BRIGHT DRAWN MILD STEEL BARS (for use in Automatic Lathes, &c.)	,,	5s.
5. BRIGHT BRASS BARS (for use in Automatic Lathes)	,,	5s.
6. DRAWN or EXTRUDED BRASS BARS (Brazing Quality)	,,	2s. 6d.
7. MILD STEEL BARS (for Loco. and Carr. and Wagon Parts)	,,	5s.
8. GALVANISED CORRUGATED SHEETS, &c.	,,	7s. 6d.
9. METALS	,,	5s.
10. PAINTS and DRYSALTERIES, &c.	,,	10s.
11. FIRE-BRICKS	,,	2s. 6d.

Tenders are due by 11 a.m. on 19th May, 1925. Tender forms obtainable at above address. Fees not returnable. 9141

PUBLIC NOTICES

TO BORE-HOLE CONTRACTORS.
County Borough of Bolton.
WATERWORKS DEPARTMENT.
SPRINGS WELL AND BROMILEY WELL.

TENDERS are INVITED for the SINKING by BORING of the above-mentioned WELLS, each having a commencing diameter of not less than 24in. and a terminating diameter of not less than 12in. at a depth of 700ft., and for the CONSTRUCTION of other WORKS connected therewith at Belmont, near Bolton.

The drawings, conditions of contract, specifications, schedules for prices, instructions to persons tendering, and forms of Tender can be seen on application to Mr. John K. Swales, M. Inst. C.E., Waterworks Engineer, 8t, George's-street, Bolton, after 11th May, 1925, and copies in respect of either or both of the wells may be obtained on the deposit of Two Guineas, which will be returned to tenderers who have submitted a bona fide Tender and returned all the documents supplied.

Tenders, separate in respect of each well, are to be submitted in accordance with the "Instructions to Persons Tendering" above referred to before 10 a.m. on the 25th May, 1925.

SAMUEL PARKER,
Town Clerk.

Town Hall, Bolton,
4th May, 1925. 9109

County Borough of Preston.
ELECTRICITY DEPARTMENT.

The Electricity Committee invites TENDERS for the PURCHASE and REMOVAL of STEAM and ELECTRICAL PLANT, including A.C. and D.C. Turbo Generators, Boilers, Switchgear, &c., installed at the Crown-street Power Station, Preston.

For further particulars apply to
THE BOROUGH ELECTRICAL ENGINEER.
9108 118, Fishergate, Preston.

Port of Bristol.
20,000-TON SILO GRANARY, ROYAL EDWARD DOCK, AVONMOUTH.

The Docks Committee are prepared to receive TENDERS for the CONSTRUCTION of a FERRO-CONCRETE-BUILT SILO GRANARY of 20,000 tons capacity, carried on Ferro-concrete Piles.

On and after Friday, the 15th day of May, 1925, copies of the specification and contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid to the General Manager and Secretary of the Docks Committee, 19, Queen-square, Bristol. ALL CHEQUES MUST BE MADE PAYABLE TO THE BRISTOL DOCKS COMMITTEE. The deposit of £5 will be returned to all bona fide tenderers after the receipt of a Tender with all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Granary," addressed to the General Manager and Secretary of the Docks Committee, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings before 10 a.m. on Monday, the 15th day of June, 1925.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Chief Engineer,
Port of Bristol.

Chief Engineer's Office,
Avonmouth Docks,
8th May, 1925. 9111

The South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of—
1. LOCOMOTIVE TANK ENGINES.
2. CARRIAGE UNDERFRAMES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W.1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked, "Tender for Locomotives," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 5th June, 1925.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £2 for each copy of Specification No. 1 and of 10s. for each copy of Specification No. 2.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, of 3, Victoria-street, Westminster, S.W.1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W.1,
6th May, 1925. 9148

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PUBLIC NOTICES

County of London.

The London County Council invites APPLICATIONS for the POSITION of PERMANENT WAY ENGINEER in its Tramways Department.

The salary will be £800 a year, rising by annual increments of £50 to a maximum of £1000 a year. The salaries mentioned are based on pre-war conditions and are subject at present to temporary additions on the Civil Service scale, fluctuating according to the cost of living. The total commencing remuneration at the present time on the existing basis is £1023 8s. 11d. a year.

Candidates must be trained and experienced road engineers, have had experience in the construction and maintenance of tramway tracks or roads, and accustomed to the organisation and control of a large staff.

Preference will be given to candidates who served or attempted to serve with H.M. Forces during the Great War.

Apply for forms (containing full details) to the Clerk of the Council, The County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary). Forms must be returned so as to be received not later than Thursday, 28th May, 1925. Canvassing disqualifies.

MONTAGU H. COX,
9131 Clerk of the London County Council.

Sudan Government Railways

REQUIRE the SERVICES of DISTRICT ENGINEERS. Age 26 to 32, preferably single. Should have good knowledge of survey and permanent way work and possess A.M.I.C.E. degree or equivalent. Preferably trained on British railway. Starting rate of pay £E480 to £E540, according to age and qualifications. Free first-class passage out and home. Progressive post if retained. Strict medical examination. —Apply by letter, giving full particulars of education, training and experience, to ADVISORY ENGINEER, Sudan Government, London Office, Wellington House, Buckingham-gate, S.W. 1, marking the envelope "District Engineers." 9117

The Government of Bombay

REQUIRE for October next a DEPUTY DREDGING MASTER in connection with the Back Bay Reclamation Scheme. Applicants must have had considerable dredging experience, including Suction Cutter Dredgers, and must be fully capable of supervising extensive dredging operations and, if circumstances require, of taking charge of large suction cutter dredger.

Four years' agreement. Salary at the rate of Rs. 800, rising by annual increments of Rs. 50 to Rs. 950 a calendar month. Free second-class passage to India and return passage on satisfactory termination of services. Provident Fund. The selected candidate will only be appointed subject to satisfactory references and to a strict medical examination.

Further particulars and forms of application should be obtained from the SECRETARY to the HIGH COMMISSIONER for INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications the 20th May, 1925. 9112

Parish of Hammersmith.

ASSISTANT ENGINEER.

ASSISTANT ENGINEER REQUIRED at the Guardians' Institution, Ducane-road, Shepherds Bush, W. 12. Candidates must be not less than 30 years of age and have had good general engineering experience.

Salary £50 per annum, rising £5 annually to £65, plus fluctuating bonus (at present £37 10s. per annum), together with board, lodging, laundry, and overalls.

Appointment subject to Poor Law Officers' Superannuation Act, 1896, and to a medical examination by Guardians' Medical Officer.

Applications on forms to be obtained from my office, to be returned to me not later than 10 a.m. on Wednesday, 13th May, 1925.

W. H. GLANVILLE,
Clerk to the Guardians.

Guardians' Offices,
206, Goldhawk-road, W. 12,
25th April, 1925. 9093

SITUATIONS OPEN

WANTED by a Large Waterworks Company (in England), a SUPERINTENDING INSPECTOR —permanent employment—about 35 years of age. Must be of active habits, good address and health, thoroughly acquainted with Modern Plumbing Work, Water Fittings and Installations in large business and trade establishments, as well as in private houses, and capable of advising consumers thereon. A thorough knowledge of Waste Detection in Mains, Domestic Service Pipes and Fittings is essential. Applicants must also have a thorough mechanical knowledge of Meters and be capable of supervising repairs thereto. The applicant appointed will also be required to supervise all meter readings (2000 meters) and keep the meter books from which accounts are made out. He will also be responsible for the Company's staff of Waste Inspectors (now nine in number), meter readers, repairers, &c., and he will be required to reside on the Company's premises and take duty outside office hours alternately with the Company's Mains Superintendent and deal with complaints and breakdowns arising at such times. Salary £300, rising by yearly increments of £20 to £400, with house rent and rates free, less 5 per cent. annual contribution to the Company's Superannuation Fund, the joining of which is compulsory. Applications will only be considered from those with good experience in similar work, and these must be received not later than May 23rd next, and must be made on forms obtainable after May 2nd on application.—Address, 9041, The Engineer Office. 9041 A

A LARGE FIRM of PUBLIC WORKS CONTRACTORS has VACANCIES for TWO well-educated YOUTHS with inclinations towards the civil engineering profession, who would be willing to serve two years on large construction contracts under the supervision of the contractors' engineer-in-charge. Small salary would be given the second year.—Apply, Box "L. P." The Westminster Advertising Service, Ltd., 26, Bedford-street, Strand, W.C. 2. 9115 A

ENGINEER REQUIRED for Responsible Position; must have broadest experience of Mechanical Design and Research, possess originality, be alert, hard worker, and of tactful and gentlemanly personality. Selected applicants will be subjected to a somewhat searching oral examination.—Address, P567, The Engineer Office. P567 A

JUNIOR ASSISTANT, Main Roads Reconstruction; sound technical training, Levelling, Drawing-office; 2 guineas.—Address, P593, The Engineer Office. P593 A

OIL ENGINES.—Progressive and Experienced YOUNG MAN WANTED, to Take Charge of Assembly, Erecting and Testing of Heavy-Oil Engines. —Address in confidence, stating fullest possible details, including age, experience, and salary required, 9092, The Engineer Office. 9092 A

RATE FIXER REQUIRED for General and Electrical Engineering Works; applicant must have served apprenticeship and able to pre-cost from drawings. State experience, age, salary expected.—Address, 9145, The Engineer Office. 9145 A

SHIPYARD and ENGINEERING WORKS MANAGER REQUIRED for abroad (Servia), to take full technical charge of small composite undertaking capable of considerable development. Must be a trained practical man, capable of conducting and directing Ship Repair and Construction, Mechanical Engineering, Foundry, and kindred work in all its details. A good organiser and energetic. A knowledge of German is essential.

Address, giving full resume of training and experience, salary required, &c., P487, The Engineer Office. P487 A

WANTED, SEVERAL Good DRAUGHTSMEN, accustomed to Steel Structural Work, Elevating and Conveying Machinery.—Address, P579, The Engineer Office. P579 A

SITUATIONS OPEN (continued)

CONSTRUCTIONAL DRAUGHTSMAN, Well Up in design of London framed steel work for engineer's office. State experience and salary required.—Address, P586, The Engineer Office. P586 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, London, S.W. 1. 8768 A

DRAUGHTSMAN, Experienced in Impulse Steam Turbines and Condensing Plants. Only first-class men need apply. State fully experience, technical training, age, and salary required.—Address, 9102, The Engineer Office. 9102 A

DRAUGHTSMAN for General Engineering and Boiler Plant Lay-outs and Details. State age, experience and salary.—Address, 9147, The Engineer Office. 9147 A

DRAUGHTSMAN (Jig and Tool) REQUIRED in S.E. London, with experience of General Engineering Work.—Address, stating age, experience, and salary required, 9120, The Engineer Office. 9120 A

DRAUGHTSMEN (SENIOR) WANTED, for Steam Turbine Details and Power Station Lay-outs. —Write, stating age, training, experience, and salary expected, to CHIEF DRAUGHTSMAN, English Electric Co., Ltd., Rugby. 9142 A

DRAUGHTSMAN. — WANTED, First - class DRAUGHTSMAN, with experience in the design of Indian Sugar Machinery. A qualified man will be liberally dealt with. State full particulars of experience, age, and salary.—Address, 8979, The Engineer Office. 8979 A

EXPERIENCED FURNACE DRAUGHTSMAN REQUIRED. State experience, salary required, and when free.—Address, 9027, The Engineer Office. 9027 A

HEATING DRAUGHTSMAN REQUIRED; Must be fully experienced, capable of scheming and estimating for large contracts. State age, experience, and salary required to the BRIGHTSIDE FOUNDRY and ENGINEERING CO., Ltd., 17, Summer-row, Birmingham. 9091 A

LARGE CRANE WORKS REQUIRE SERVICES of an experienced DRAUGHTSMAN in Steam and Electric Cranes, accurate and reliable. Age 26-30 years.—Address, giving full particulars of experience and salary, 9122, The Engineer Office. 9122 A

LEADING STRUCTURAL DRAUGHTSMAN REQUIRED in Birmingham area. Only fully experienced senior men need apply.—Address, 9103, The Engineer Office. 9103 A

MACHINE TOOL DRAUGHTSMAN WANTED, experienced in Special Tool design.—Address, stating experience, age, and salary required, 9105, The Engineer Office. 9105 A

MECHANICAL DRAUGHTSMAN WANTED by Firm in London area, with first-class technical and shop training. Only men exceptionally well up in problems of mechanical design need apply.—Address, stating age, salary, and experience, 9037, The Engineer Office. 9037 A

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Limited, Trafford Park, Manchester, REQUIRE the SERVICES of DRAUGHTSMEN on Switchgear Apparatus. Neatness, accuracy and quickness essential. Electrical qualifications desirable, but not imperative.—Written applications to be addressed to EMPLOYMENT DEPT., giving particulars of training, experience and salary required. 9012 A

TWO First-class DRAUGHTSMEN REQUIRED, accustomed to Detailing Steel-framed Buildings of all types.—Applications, endorsed "Draughtsmen," and stating age, experience and salary required, to LAMBOURNE and CO., Ltd., Victoria Steel Works, Openshaw, Manchester. 9074 A

FOUNDRY UNDERFOREMAN REQUIRED by large firm, London district; must have had extensive experience in the Production of intricate Castings in Aluminium for Aero-engine Work.—Address, stating age, details of experience in date order and salary required, 9140, The Engineer Office. 9140 A

WORKS FOREMAN REQUIRED, East Midlands, with Pumping Machinery experience, used to accurate heavy work with general purpose machines, and capable organiser. State experience, salary and when disengaged.—Address, 8900, The Engineer Office. 8900 A

SITUATIONS WANTED

WANTED, POSITION with Firm of Consultants in London; first-class technical, workshops and maintenance experience; A.M.I.M.E., A.C.G.I.; British, age 28; applicant can call with references.—Address, P591, The Engineer Office. P591 B

ASSIST. WORKS MANAGER, Mech. Eng., Hons., 23 years' exp. 1st class firms, general and mass production engineering, sound knowledge machining problems, com. and D.O. exp., DESIRES Managerial APPOINTMENT or represent good eng. proposition, tools, accessories. Excel. refs.—Address, P557, The Engineer Office. P557 B

CIVIL ENGINEER (Dipl.), Swiss, 3 Years' Practice in concrete work (office and works), French, Italian, German, and English speaking, WANTS suitable SITUATION in England or Colonies.—Address, P581, The Engineer Office. P581 B

ENGINEER, B.Sc., A.C.G.I., 3 Years' Workshop, 1 year office experience, DESIRES POSITION where technical training and practical knowledge of motor cars and cycles will be of use; age 24 years; moderate salary.—Address, P592, The Engineer Office. P592 B

ENGINEER (28), Single, Apprenticeship Completed first-class Clyde shop, 3½ years watch keeping engineer passenger vessels, 3 years foreman plant maintenance, factory and repairs shop, thoroughly understands upkeep steam and electric plant, installation, correspondence, SEEKS SITUATION. Continent or the East. Good testimonials.—Address, P583, The Engineer Office. P583 B

GENERAL WORKS MANAGER, with Successful record in management of large engineering works (steam and internal combustion), will shortly be open to ACCEPT similar POSITION. Has extensive experience with modern works plant and organisation to ensure economical production of high-class work in large quantities. Highest references supplied.—Address in first instance, P553, The Engineer Office. P553 B

MAINTENANCE ENGINEER (38) SEEKS POSITION; 18 years' experience with steam, hydraulic, compressed air, and general maintenance work, including machine tools; 5 years with large American locomotive firm; has had charge. Good references; go anywhere.—Address, P543, The Engineer Office. P543 B

STORES CLERK (27 Years) SEEKS POSITION, home or abroad; 10 years' experience pumps and gas engines; excellent references from well-known firm.—Address, P594, The Engineer Office. P594 B

TRAINED STEEL CONSTRUCTIONAL ENGINEER (26) DESIRES CHANGE; B.Sc. (Distinction), works, D.O. and commercial experience. Quick and accurate designer.—Address, P589, The Engineer Office. P589 B

SITUATIONS WANTED (continued)

Sales Promotion Expert

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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

An Oil Well Tube Contract.

TENDERS were recently invited by the Anglo-Persian Oil Company from British and foreign firms for a large amount of casings for oil wells. On receipt of the tenders it was found that the German quotation was one-third lower than the lowest British figure. It was realised that the German tube manufacturers were in a position to submit a low tender by reason of their organisation which enabled them to distribute the work among a number of factories. The Anglo-Persian Company, anxious to place the order in this country if at all possible, invited two of the British tenderers, Stewarts and Lloyds, Ltd., and the British Mannesmann Tube Company, Ltd., to reconsider their quotation and to submit a revised tender based on a combination of their resources and the division of the work between them. This suggestion was carried out and the companies submitted a revised offer, which was still a little higher than the German figure, but not sufficiently so to debar it from consideration. The contract has now been awarded to them. The sum involved is stated to be about £100,000. It is suggested that by a similar procedure other firms might be able to retain in this country orders of a type that recently have been going with distressing regularity to the Continent.

The Shipbuilding Trades' Investigation.

THE first meeting of the joint committee of shipbuilding employers and the trades unions, which took place on Friday last, was marked, we understand, by a desire on both sides to recognise the importance of the investigations, and the necessity of restoring prosperity to the British shipbuilding industry. A full discussion on the scope of the inquiry and the method of procedure took place, but it was agreed that the proceedings were of necessity of a confidential character. It was therefore decided that no public statement should be made until conclusions had been reached and recommendations could be made. The need for this inquiry into production costs, both within and without the industry, is emphasised by the announcement that in a recent tender for eight refrigerated meat ships to be built for the Blue Star Line there was something like £20,000 difference per ship in favour of the Continent between the lowest British tender and the lowest continental tender. The continental tenders which were lower than the British offers included quotations from both Dutch and German yards. In all, the contract for the eight ships, each of about 12,000 tons deadweight, will amount, we understand, to about £2,000,000, and every effort is being made to secure this valuable order for British yards, especially so as hitherto the Blue Star Line has not placed orders for its ships with any foreign builders.

Waterloo Bridge.

FROM the first of the month Waterloo Bridge across the Thames was again closed to vehicular traffic. On this occasion the object in view is to facilitate the completion of the temporary steel bridge which is being erected on the down-stream side of Rennie's structure, which bridge will carry the traffic across the river while during the ensuing years the old stone bridge is being reconstructed or replaced. The work of completing the temporary bridge involves the assembly of a steel span 280ft. in length and 600 tons in weight. This span, the equivalent in length of two of the stone arches, is being assembled on the old bridge roadway, and when completed will be translated 90ft. down-stream and lowered on to the timber and steel cylinder piers on which the new temporary bridge is carried. The double span, it is hoped, will facilitate the navigation of the river below the new and old bridges. The old structure, it is anticipated, will remain closed until the end of next month.

New Atlantic Liners.

IN spite of the prevailing depression in shipping and shipbuilding, there appears to be no lack of enterprise on the part of the companies engaged in the Atlantic passenger and cargo-carrying trade. During last week end successful trials were run in the North Sea of the new Cunard liner Ascania, which has been built by Sir W. G. Armstrong, Whitworth and Co., Ltd., on the Tyne. The Ascania arrived at Southampton on Monday, the 4th inst., and is scheduled to sail from Southampton on her maiden voyage to Quebec and Montreal on May 22nd. She is a ship of 14,000 gross tons and is propelled by twin-screw double reduction geared turbines with oil-fired boilers. The refrigerator space in the ship is unusually large and the machinery and pipe arrangements are adapted for a wide range of working. The new liner is a two-class ship, designed to carry about 520 first-class and 928 third-class passengers. Special attention has been given to the third-class quarters, which are designed to attract passengers of the tourist class. The Ascania will shortly be followed by the Cunarder Alaunia—practically a sister ship—and later by the Carinthia, a liner of some 20,000 gross tons. It is reported that the White Star Line has placed with Harland and Wolff, Ltd., an order for a 16,000-ton passenger and cargo vessel which is to be constructed at Belfast. At the time of writing, however, the owners are not in a position to deny or confirm the truth of this report. Another Atlantic liner which is now within measurable distance of completion is the 17,000-ton Anchor liner Caledonia. She was launched from the Linthouse yard of Alex. Stephen and Sons, Ltd., on the 21st of last month, and is now being fitted out. Like the Transylvania, she will have three funnels. Although primarily designed for service between Glasgow and New York, the Caledonia is also to be used for special extended cruises.

A New 16-Inch Projectile.

AT the annual meeting of Hadfields, Ltd., at Sheffield, on Friday, May 1st, the chairman, Sir Robert Hadfield, announced that a new type of 16in. armour-piercing shell, produced by his firm for the British service, had satisfactorily undergone tests of the most stringent character. A few years ago, he added, it would have been deemed impossible to manufacture a shell capable of passing the tests in question. The new projectiles are apparently intended for use in the 16in. guns which are to form the main armament of the battleships Nelson and Rodney, now under construction. It is satisfactory to learn that they will be fully equal to the exacting demands now made upon armour-piercing shell for the naval service. Experience gained at the Battle of Jutland showed the ordinary tests applied at the proof butts to be inadequate. A shell that would pierce a given thickness of plate when striking at right angles was liable to break up when holing the same plate at an oblique angle, and to this weakness on the part of our projectiles is attributed the escape of several German capital ships which were hit repeatedly in the course of the action. A committee appointed by Lord Jellicoe in 1917 evolved an improved type of shell which "would at the same oblique impact and range pass whole through a plate of twice the thickness before detonating, and could, therefore, with delay-action fuse, penetrate to the magazines of a capital ship." It is possible that the new Hadfield projectile represents a further development in this direction, in which case the armament of our new battleships will be more formidable than the mere number and calibre of the guns would indicate.

The First Wright Aeroplane.

THE historic aeroplane with its small home-made four-cylinder petrol engine on which Wilbur and Orville Wright in the autumn of 1903 made their first power-driven flight at Kitty Hawk, South Carolina, is, it seems, now lying at Dayton, Ohio, packed in crates ready for shipment to the Science Museum at South Kensington. Mr. Orville Wright, it is reported, has expressed his regret at having to send the machine to a museum outside his own country. His decision to do so has been dictated by the action of the Smithsonian Institute at Washington, which in 1914 allowed the Langley "Aerodrome" entrusted to its care to be taken away, modernised and modified and otherwise made to fly with the object, so it said, of proving that Samuel Langley had anticipated the Wrights' invention and of providing evidence for a law suit attacking the validity of the original Wright patents. Mr. Wright refuses to allow any museum discretion to make alterations in his machine, and adds that if half the changes permitted in the Langley aeroplane were allowed in the Kitty Hawk machine it could easily be proved that his aeroplane was not capable of sustained free flight. The Smithsonian Institute has defended its action in permitting the alterations to and experiments with the Langley machine on the ground that it was not a historical relic, but was received from the War Department for the purposes of experiment. There can, of course, be little doubt that no such treatment of a pioneer device of whatever nature and however received would be permitted by any museum authority in this country.

British Tariff and French Trade.

AN outstanding feature of the French trade returns is the increasing exports of French goods to Britain and the diminishing importance of the value of British consignments to France. Britain is by far the most valuable market for French manufacturers. Business with this country represents a "balance of trade" in favour of France which our neighbours have been able to increase under cover of their currency depreciation, and while taking full advantage of the free market offered to them they have carefully abstained from doing anything in the way of reciprocity whereby British manufacturers might be able to dispose of their products in France. The situation was one which, if it had continued, would have inevitably accentuated the economic subservience of this country, at all events so long as there exists the present considerable discrepancy in money values. The protection of British industries by the restoration of the McKenna duties on certain foreign manufactured goods has therefore caused something like consternation across the Channel. Manufacturers of motor cars will be particularly affected by the new duties. Owing to the heavy falling off in the home demand the French automobile industry is in a very precarious situation, and makers have been endeavouring to unload as much of their production as possible on the British market at prices which appear low in sterling values, but which leave a good profit to French makers in their own currency. It is recognised that the French motor car industry suffered during the time the McKenna duties were in operation, and one of the biggest French makers was even preparing to put down a works in England for the production of his cars. As soon as the duties were suppressed the project was abandoned.

A Colliery Co-partnership Scheme.

AS a consequence of the depression in the iron and steel industries and the reduced demand for coke, three thousand men in the employ of the Birchenwood Colliery Company, of Kidsgrove, Stoke-on-Trent, were recently given notice to cease work to-morrow, Saturday. Last Friday, however, the directors invited representatives of the North Staffordshire Miners' Federation to meet them in order to discuss a scheme for keeping the pit open by working it on a co-operative basis. The scheme, unlike that which is meeting with considerable success at the Vauxhall Colliery in North Wales, involves the element of co-partnership. A trust fund, it is proposed, shall be established to which the royalty owners, the staff and the workmen shall contribute 15 per cent. of all payments accruing to them from to-morrow onwards. From this fund interest at the rate of 5 per cent. per annum will be paid on the money required to keep the colliery at work and to compensate the company for any loss sustained. By this means a sum of about £1000 per week would be paid into the fund, which, it is explained, would be administered by trustees. Should any profit be made by the company after meeting all liabilities, it is to be paid into the fund until the amount of the fund is equal to the total sum plus interest contributed to it by the royalty owners, the staff and the workmen. When that point is reached the contributors will have the choice of withdrawing their money together with interest on it or of acquiring co-partnership shares in the company to a proportionate amount. The local union is considering the proposal, but in view of the opposition of the National Federation to arrangements involving co-partnership at individual collieries, it is not quite certain that the scheme will be approved and given a trial.

New Dry Dock at Tilbury.

AT a meeting of the Port of London Authority last week approval was given to the expenditure of £715,000 on the construction of a new dry dock at Tilbury. The new dock will be to the east of the existing dry docks and will open into the main wet dock. It will have a length of 750ft., a width of 110ft., and a depth of 37ft. 6in. below the Trinity high-water level. With these dimensions, it is estimated, the dock will accommodate not only the largest vessels at present entering the Port of London, but all those likely to do so for some years to come. Should the necessity arise in the future, the dock will be lengthened to 1000ft.

Continental Protection.

FOREIGN industrial countries have been so long struggling to restore normal economical conditions that they now see little hope of salvation beyond adopting a policy of protection adapted to present needs. The Swiss Government has prepared a fiscal programme which aims at facilitating the importation of raw material and of products conducive to cheap living, but which imposes considerably heavier duties upon all goods that are not indispensable and may be regarded as luxuries. In the same way, all other countries are strengthening their protective barriers and are leaving so few loopholes that it is becoming increasingly difficult to carry out negotiations for commercial agreements. At a time when the different countries were dependent upon each other commercial treaties were negotiated on a sufficiently broad basis to encourage trade development; but now that each country aims at producing everything required for its own needs there is little left for reciprocity. The interminable negotiations between France, Belgium and Germany prove that the changed economical conditions have greatly restricted the opportunities for international trade. A new element of severe competition has been introduced which will favour those countries possessing special advantages for cheap production until the conditions become normal again. There is little hope for this condition being produced except by a return to the gold standard. Now that that standard is being adopted in the British Empire the French find themselves left in what they regard as a position not only humiliating to themselves, but detrimental to the country's financial status. Not until the French succeed in coming back to the gold standard will there be sufficient stability to permit of a normal development of international trade.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XIX.*

LOCOMOTIVES BUILT BY BRITISH FIRMS FOR ABROAD (INCLUDING THOSE FOR COLONIAL AND INDIAN RAILWAYS).

WITH the exception of one or two engines of special design built in 1832–3 for American railways, no mention has so far been made of locomotives exported overseas, because until about 1852 the types and classes were generally of the makers' standard designs used in this country.

European Railways.—The products of the majority of the British locomotive manufacturers were represented on the European Continent, though the larger number of engines were by Stephenson and Sharp. Before 1850 the output of the French and German firms had become equal to the requirements of these countries, and with a few isolated exceptions, orders from the latter ceased. By 1856 the export of engines to Belgium had also practically stopped. There still remained a trade with railways in other countries, which were later in adopting railway transport.

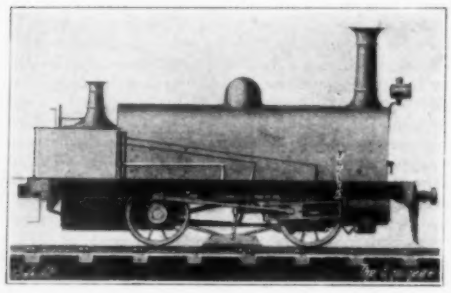


FIG. 139—ENGINE FOR GIOVI INCLINE

It is not proposed, nor is there any necessity, to describe engines built for the Continent, except in the case of two special designs which were not represented in this country.

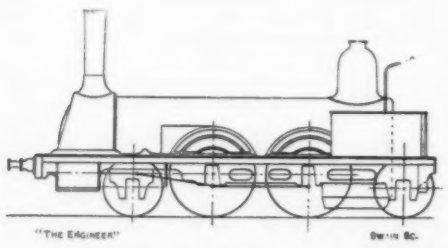


FIG. 140—STEPHENSON'S ENGINE FOR BELGIUM, 1860

Twin Tank Engines by R. Stephenson and Co. for the Giovi Incline, Italy.—These were built for working the heavy gradients of 1 in 29 to 1 in 36 on the main railway between Turin and Genoa. The problem of special locomotives for long steep gradients with severe curves confronted continental engineers before its solution was demanded from British builders, and in 1852 the Austrian Government offered prizes for locomotives adapted to work the Semmering inclines. No British makers competed, and of the four special designs evolved, those by Maffei and Engerth never had their counterparts in British practice. On the other hand, the double boiler articulated locomotive on two steam bogies, by Cockerill, of Seraing, was the forerunner of the Fairlie engine, and the single boiler articulated engine, by W. Gunther, of Wiener Neustadt, was the prototype of the Meyer type.

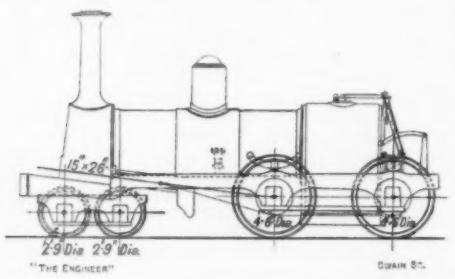


FIG. 141—HAWTHORN'S ENGINE FOR SOUTH AMERICA

The Italian engineers were not satisfied with the designs for the Semmering, and suggested that two engines placed back to back would be simpler, provided they were arranged with the equivalent of a single footplate so that one engine driver could be responsible for their working, though two drivers and one fireman were subsequently employed. Robert Stephenson was consulted and approved of this suggestion.[1]

The first Giovi engines of 1855 consisted of two 0–4–0 saddle-tank locomotives back to back. One of these units is shown in Fig 139.[2] The saddle tank contained 3 tons of water, and was of such a length that the ratio of weight distribution on the two axles remained approximately the same as the water and fuel were consumed. The cylinders were 14in. by 22in., and the coupled wheels 3ft. 6in. diameter; wheel base, 8ft. 6in.; total heating surface, 731.5 square feet; weight in working order, 27 tons 12½ cwt. The maximum total adhesive weight for the pair of engines was, therefore, 55¼ tons, but as there were 2½ miles of damp tunnel, in which the coefficient of adhesion was low, the boiler pressure was limited to 88 lb.

The excentric sheaves were forged solid with the driving axle, and sledge brakes, the shoes of which were 2ft. 8in. long, were provided.

In service it was found that the weight of more than 13¾ tons per axle was too great for the rails, and subsequently Messrs. Stephenson built twin 2–4–0 and 0–6–0 types for the same railway.

The twin system with two engines back to back was also used in India (1858) and on the Cape Government Railways (1875).

2–4–2 Passenger Tender Engine.—The 2–4–2 type so long associated with French practice, had its origin in this country in 1860, when R. Stephenson and Co. built an engine—Fig. 140—for the Belgian Great Luxembourg Railway.[3] Robert Sinclair, through whom the engine was ordered, suggested that Messrs. Stephenson should take their long boiler 2–4–0 engine with outside cylinders and add a pair of small wheels at the trailing end, and he also proposed that both the leading and trailing axles should be made to swivel by means of Bissell trucks.[4] This would have resulted in an unsteady motion, and the engine was built with a "Bissell" at the leading end only, and was the first constructed in this country with a two-wheeled pony truck. The length of the radial arm was 4ft. 0½in. The cylinders were 15in. by 22in., coupled wheels 5ft. 6in., and leading and trailing wheels 3ft. 8in. diameter. Wheel base 5ft. 4in. + 6ft. + 6ft. = 17ft. 4in. The boiler contained 121 2¼in. tubes, 13ft. 10in. long. Heating surface 1001 square feet, of which the fire-box provided 70½ square feet. The sloping smoke-box front was a feature of many of Sinclair's designs. Compensating levers were placed between the springs of the coupled wheels.

The 2–4–2 tender engine never took root on British railways, for which none were ever built, unless exception be made of twenty Webb compound locomotives of the "Greater Britain" type of 1891 with uncoupled driving wheels. From 1873 onwards it was adopted on some of the French railways on a very large scale, and there were also many examples in Belgium and Germany.

Bogie Locomotives for Abroad.—The severe curves on some of the Chilean and Peruvian railways necessitated the use of bogies. R. and W. Hawthorn's engines for the Arica and Tacna Railway—Fig. 141—had inside cylinders 15in. by 26in., coupled wheels 4ft. 6in. and bogie wheels 2ft. 9in. diameter; bogie wheel base, 3ft.; total wheel base, 18ft. 2in. In 1858 Messrs. Kitson built four 4–4–0 engines—Fig. 142—with outside inclined cylinders for the Copiapo and Caldera Railway. The tenders were also carried on two four-wheeled bogies. The engine bogie had a fixed centre pivot, 3ft. 6in. wheels and 5ft. base; cylinders, 16½in. by 24in.; coupled wheels, 5ft. 2in. diameter; total wheel base, 15ft. 6½in., the distance between the coupled wheel centres being 8ft. 3in. Total heating surface, 1068 square feet. The American cab with open front and weatherboard may be noticed. Both connecting and coupling rods were of circular section.

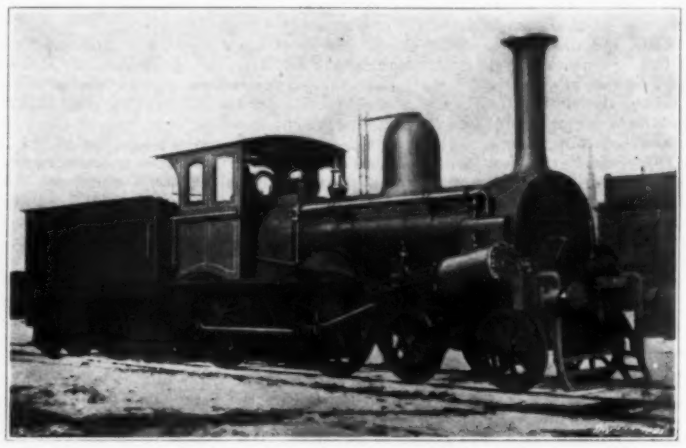


FIG. 142—KITSON'S ENGINE FOR CHILE, 1858

R. Stephenson and Co. also built ten 4–4–0 engines with outside cylinders for the Smyrna–Aidin Railway in 1859. The cylinders were horizontal, and the bogie necessarily had a long wheel base in accordance with modern standards.[5]

The first 4–6–0 engines built in this country, which the writer can trace, were made by R. and W. Hawthorn in 1860 for the Copiapo Extension Railway to the general designs of Mr. Edward Woods. The rails weighed only 42 lb. to the yard, and the weight on any pair of wheels could not exceed 7 tons, so that three coupled axles were necessary. The coupled wheels had a diameter of 4ft., and the outside cylinders were 16in. by 24in., coupled wheel base 10ft. 9in., the front pair being without flanges. The whole of the motion was outside, Gooch's valve gear being used.

Locomotives for Egypt.—The first engines for Egypt were built in 1852 by R. Stephenson and Co. They were 2–4–0 passenger engines with inside frames and inside cylinders, 14in. by 20in. The fire-box casings were of the old "Gothic" type. Amongst the many types built between 1852 and 1860 by various British firms the canopied 2–2–4 tank engine—Fig. 143—deserves mention. It was made by Messrs. Stephenson in 1859 for the Viceroy's private use, and, like many Egyptian locomotives of that period, was most elaborately and expensively decorated. The cylinders were 8in. by 14in.; diameter of driving wheels, 5ft.; total heating surface, 409½ square feet.

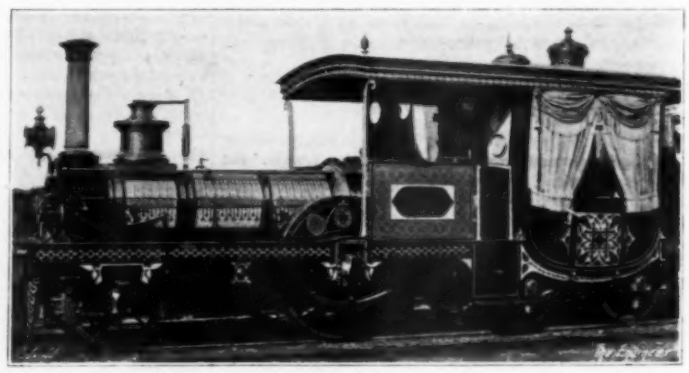


FIG. 143—STEPHENSON'S ENGINE FOR EGYPT, 1859

Messrs. Stephenson also built in 1860 two heavy 0–6–0 goods engines with 5ft. wheels and 17in. by 28in. cylinders. These were the first built in this country with such a long stroke.

Locomotives for British Colonies.—The earliest engines exported went to the other side of the Atlantic. In 1838 Timothy Hackworth built three six-coupled engines with vertical cylinders and return-flue boilers for the Albion Coal Mining Company, Nova Scotia. They were fitted with parallel motion instead of crossheads and guide bars.[6] They appear to have been the first locomotives in what is now the Dominion of Canada.

In 1845 Sharp Bros. built four single-driver engines for Jamaica, and in 1853 sent an engine to Demarara.

It was not until 1854 that the first locomotives were sent to Australia—see Fig. 144. Built by Stephenson and Co. for the Sydney and Goulburn Railway, they were obviously of J. E. McConnell's design, and had 5ft. 6in. leading and driving wheels and 16in. by 24in. cylinders. One of them is still

* No. XVIII. appeared May 1st.

[1] The original idea was due to T. R. Crampton, who patented it in August, 1846 (Colburn, page 91).

[2] For this illustration the writer is indebted to R. Stephenson and Co., Limited, Darlington.

[3] During the same year Schneider, of Creusot, built two 2–4–2 passenger engines for the Great Russian Railway.

[4] For this information the writer is indebted to R. Stephenson and Co., Limited.

[5] One of these engines is illustrated in "A Century of Locomotive Building," page 410.

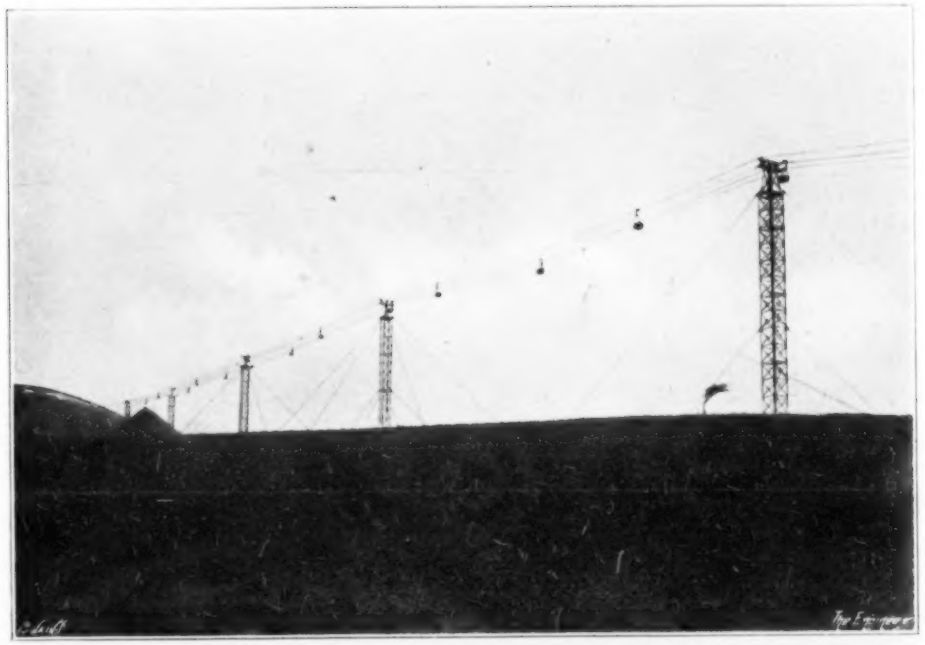
[6] These engines are described and illustrated in "Timothy Hackworth and the Locomotive," by Robert Young.

SOME STEEP COLLIERY ROPEWAYS IN SOUTH WALES

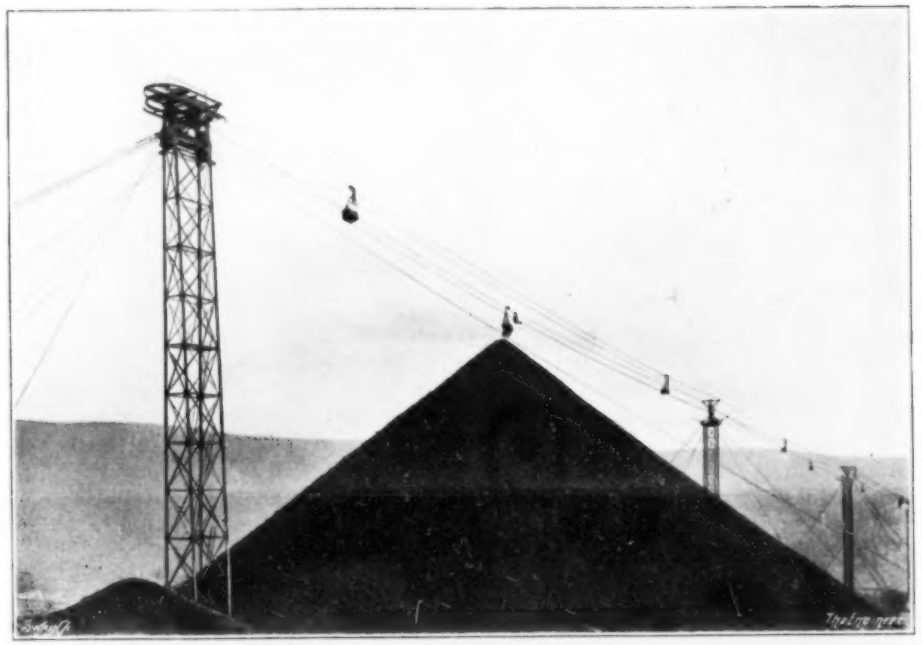
R. WHITE AND SONS, WIDNES, ENGINEERS

PENLLWYNGWENT ROPEWAY—MOUNTAINSIDE SECTION

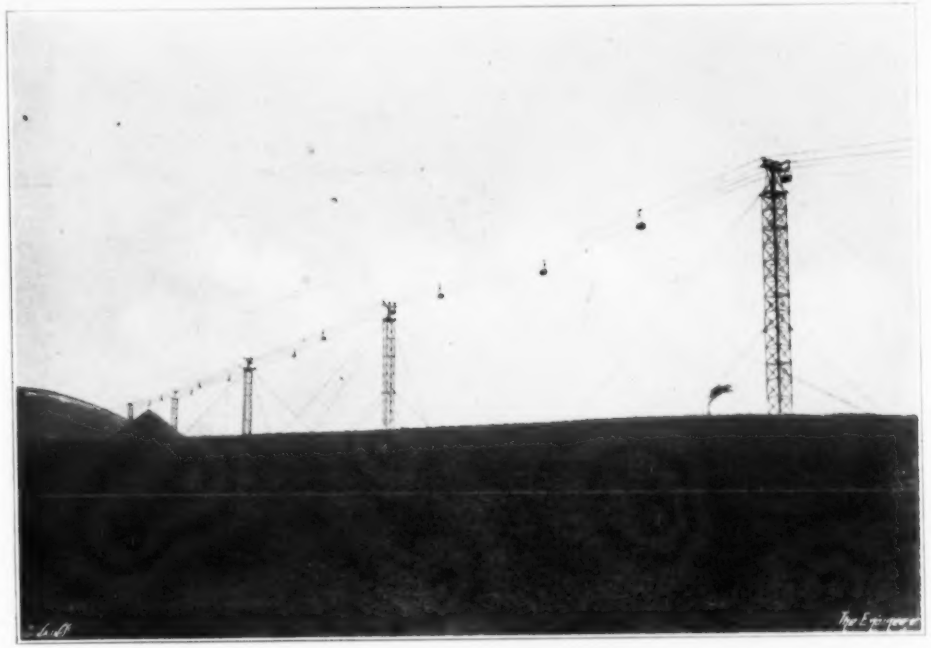
PENLLWYNGWENT ROPEWAY—RETURN TERMINAL AND DUMPING GROUND



WYNDHAM ROPEWAY—DUMPING SECTION



WYNDHAM ROPEWAY—RETURN TERMINAL



WYNDHAM ROPEWAY—DUMPING SECTION

WYNDHAM ROPEWAY—RETURN TERMINAL

BWLLFA ROPEWAY—THE FIVE ORIGINAL DUMPING TOWERS

BWLLFA ROPEWAY—THE UPPER PART SOME EIGHT YEARS AGO

BWLLFA ROPEWAY TO-DAY—NOTE DERELICT TOWER ON LEFT

BWLLFA ROPEWAY TO-DAY—NOTE LOSS OF ALIGNMENT

preserved at Sydney. Two engines by Stephenson and Co., 1859, for the Adelaide and Gawler Bridge Railway, South Australia, were of the 4–4–0 type with leading bogies. The earliest Victorian engines were built by Stephenson's in 1855 for the Geelong Railway, and were followed by others in 1857 by George

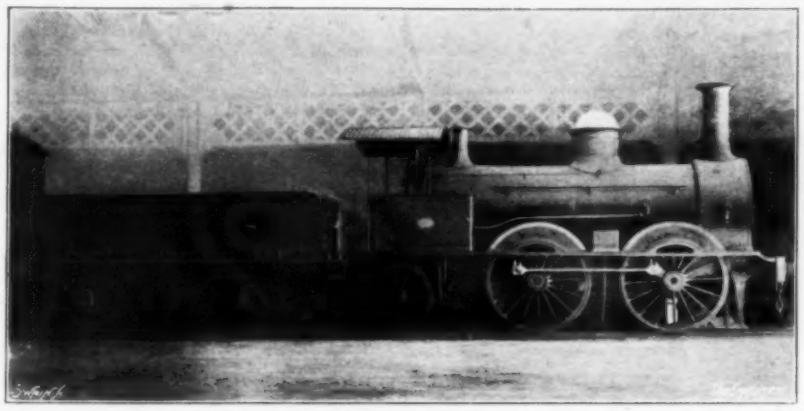


FIG. 144—STEPHENSON'S ENGINE FOR NEW SOUTH WALES, 1854

England and Co., of Hatcham Ironworks, London.

Locomotives for India.—Comparatively little has been published concerning the earlier Indian engines, so that a few brief notes may be of some interest.

The first public railway to be opened for traffic was the 5ft. 6in. gauge section of the Great Indian Peninsula Railway between Bombay and Thana, on April 16th, 1853, followed by an additional length to Kalyan, 33 miles. The first main line locomotives in India were eight 2–4–0 engines built by the Vulcan Foundry in 1852—see Fig. 145—for the above section of the G.I.P.R. They were of very small dimensions, the cylinders being only 13in. by 20in. and the coupled wheels 5ft. dia.; total heating surface, 777¼ square feet. The high dome-shaped fire-box casing and the

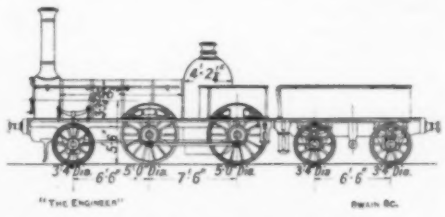


FIG. 145—VULCAN ENGINE FOR INDIA, 1852

tender wheels with inside bearings were the principal features.

These engines had inside frames and bearings throughout. This simple design was a feature of the 5ft. 6in. gauge locomotives for India, and with only one exception outside or double frames were never used. The additional width between the frames due to the wider gauge allowed ample room for inside bearings of adequate length and crank webs of sufficient thickness. The "mixed" frame, in which the carrying wheels only had outside bearings, was also rare, the exceptions being a few 2–2–2 and 2–4–0 engines of the "Crewe" type with outside cylinders. Inside cylinders were the general rule, though between 1860 and 1869 the majority of the East Indian Railway engines and a limited number

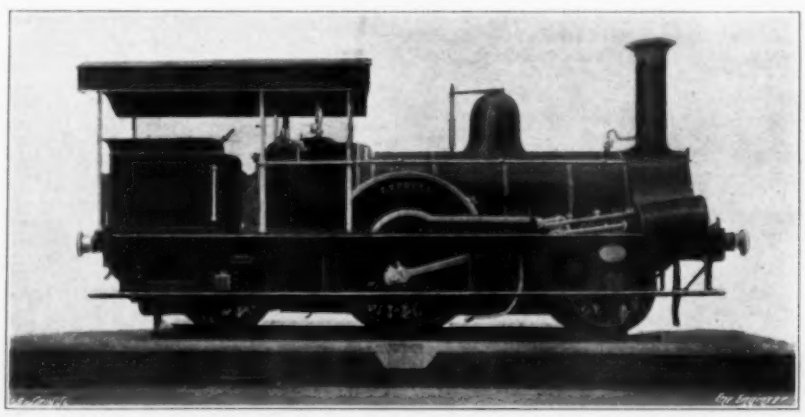


FIG. 146—LOCOMOTIVE FOR THE EAST INDIAN RAILWAY, 1856

on other lines were built with outside cylinders.

Returning to the G.I.P.R., the subsequent passenger engines by Kitson and Co., 1856, were of a larger 2–4–0 type with 5ft. 6in. coupled wheels and 15in. by 21in. cylinders. This type, with cylinders enlarged to 16in. by 22in., was the favourite design for about twenty years on most Indian railways.

The first Ghat engines were built by E. B. Wilson and Co. in 1856.[7] They were four-coupled tank engines, which worked in pairs back to back similarly to Stephenson's Giovi tank engines. Each of Wilson's engines had outside cylinders, 15in. by 22in. and 4ft. wheels.

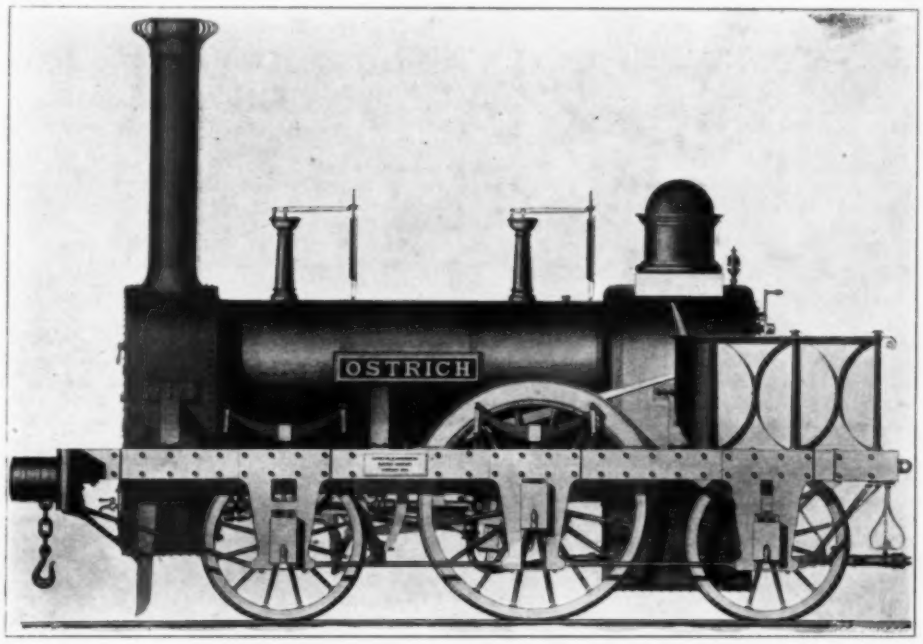
The first main line passenger engines for the East Indian Railway, built in 1855–6 by Beyer, Peacock and Co., the Vulcan Foundry, and E. B. Wilson, were of the 2–2–2 type with 6ft. 6in. driving wheels and 15in. by 22in. inside cylinders. The weight of the engine in working order was 27¼ tons and of the six-wheeled tender 20½ tons.

The goods traffic of the E.I.R. was for more than twelve years conveyed by four wheels coupled "mixed traffic" engines of the 0–4–2 type. There were eighty of these engines by the Vulcan Foundry, Hawthorn, E. B. Wilson, Kitson, Fairbairn, and Stothert and Slaughter. The cylinders were 16in. by 22in.; diameter of coupled wheels, 5ft.; of trailing wheels, 3ft. 9in.; total heating surface, 1156 square feet; grate area, 18 square feet. Many of these engines had a length of service of forty to forty-five years.

A historic East Indian 2–2–2 tank engine is shown in Fig. 146. A number of engines to this design were built by Kitson and by Stothert and Slaughter in 1856–7 for local traffic in the Calcutta district. The engine "Express," illustrated, was one by the former firm. It had 6ft. driving wheels and 12in. by 22in. cylinders. It has the appearance of John V. Gooch's Eastern Counties design with outside cylinders and mixed framing. The Express is now preserved on a pedestal on which it was placed in 1901 during Mr. Alan W. Rendell's superintendency. The inscription records that it was the first locomotive which ran passenger trains between Howrah and Raneegunge, and also that it conveyed troop trains to the latter station during the memorable year 1857.

A number of early tank engines on the E.I.R. were of the 0–4–2 type with coupled wheels 4ft. diameter and outside cylinders 12in. by 18in.; they were followed by a somewhat larger class with 4ft. 6in. wheels and 14in. by 18in. cylinders. All were built in 1857–9 by Stothert and Slaughter, of Bristol.

The Madras Railway 2–2–2 passenger engines by Kitson, 1856, were similar to the tank engine "Express" of the E.I.R., but were provided with separate tenders. This railway was the first in India to employ 0–6–0 goods engines. They were built to Mr. (afterwards Sir) John Hawkshaw's designs by Beyer, Peacock and Co. in 1858, and had 5ft. wheels and 16in. by 22in. cylinders. The weight in working order was 28½ tons; the tender weighed 19¾ tons when fully loaded. In appearance they were somewhat similar to the goods



DEWRANCE'S LIVERPOOL AND MANCHESTER RAILWAY, 1841-5

engines—Fig. 125 *ante*—built by the same firm for Egypt, and were fitted with the Jenkins arch and tubular stays in the front wall of the fire-box, as used on the Lancashire and Yorkshire Railway for coal burning. A number of typical Indian locomotives of this period were illustrated in THE ENGINEER as follows:—0–4–2 engine, by Beyer, Peacock, April 26th, 1867; 2–4–0 engine, by Sharp, Stewart, March 27th, 1868; 0–6–0 engine, by Sharp, Stewart, June 12th, 1868.

[7] The first started work in July, 1858. In the early days of Indian railways, locomotives had to be built 1½ to 2 years before they were placed in service.

ADDENDUM.

In THE ENGINEER of February 13th last, page 179, there was illustrated in Fig. 45 a sectional elevation of one of the standard 2–2–2 passenger engines for the Liverpool and Manchester Railway, built during 1841–1845 at the company's works at Edgehill, Liverpool, to the designs of John Dewrance, then locomotive superintendent. By the courtesy of Sir John Dewrance we are able in the illustration above to reproduce, from an original drawing made by his father, an outside view of one of these engines, the "Ostrich." The date plate bears the inscription: "Liverpool and Manchester Railway Company, February, 1842." The driving wheels had a diameter of 5ft., and the cylinders were 12in. by 18in. According to the Gauge Report Appendix, the average weight of these engines was 15½ tons "when charged."

THE new turbine steamer Glen Sannox, of the London, Midland and Scottish Railway, is to have a speed of 23¾ knots. She will be very similar to the Duchess of Argyll.

Heavy-Oil Engines:

Some Outstanding Questions Relating to Large Engines of the Self-Ignition Type.*

By Captain H. RIALL SANKEY, C.B., C.B.E., R.E., M. Inst. C.E.

MANY fruitful years of development of the internal combustion engine have elapsed since Sir Dugald Clerk delivered the twelfth "James Forrest" Lecture in 1904, entitled "Internal Combustion Motors." This development has been most striking in the case of the petrol engine for motor vehicles and aircraft, and of the heavy-oil engine. But the advance in the case of the large gas engine has been comparatively small, as even in 1906 an Oechelhauser gas engine had been built developing 1500 horse-power in a single cylinder of 43.3in. diameter.

The technical difficulties experienced twenty years ago in large gas engines from high cylinder temperatures combined with high pressures are much intensified in the case of large heavy-oil engines by the higher pressures; and in their case it cannot be said that these difficulties have been completely overcome. The heavy-oil engine has also to contend with fuel injection difficulties, resulting in imperfect combustion and sometimes in so-called "detonation."

I propose to discuss these and other difficulties as they exist to-day. Broadly, the temperature difficulties do not arise with cylinders less than 18in. diameter, but they increase rapidly with size, so that a cylinder of 33in. diameter is the largest so far in commercial work, although an experimental engine with a cylinder of 39.37in. (1000 mm.) was built even as far back as 1914 by Sulzer's, and it is understood that at present engines with cylinders of 43in. are in contemplation. It is worth noting that gas engines with 50in. cylinders have been built.

In this lecture I will confine myself to those "heavy-oil engines" that, working either on the two or the four-stroke cycle, compress air to a temperature sufficient for the self-ignition of an injected fuel of not less than 0.82 specific gravity.

FUEL INJECTION.

In these heavy-oil engines the fuel is injected into hot compressed air a little before the top of the stroke, and in most cases only a small increase of pressure above that of compression takes place on combustion, because the phenomenon is that of rapid burning as distinct from explosion. The rate of combustion is largely regulated by the size of the oil particles produced by the atomisation; preferably, all the particles should be of medium size; larger particles take much longer to burn and from want of oxygen may burn with a smoky flame. The particles may, however, be too small, as they will then lack penetrative power in the dense air of a pressure of about 500 lb. per square inch—at any rate, in the case of mechanical injection. It can be shown that a particle of oil 0.004in. in diameter, starting with a velocity of 500ft. per second, would have its velocity reduced to 3.5ft. per second in travelling 0.35ft., whereas if 0.0002in. in diameter the same reduction in velocity would occur in travelling only 0.05ft.

It follows from the above that instead of completing the atomisation of the oil as it issues from the "atomiser," it should issue in a number of compact threads directed to different parts of the combustion chamber to break up into a cloud before reaching a metallic surface. Such an arrangement, combined with adequate turbulence, would ensure each molecule of oil reaching the necessary oxygen to produce a sufficiently rapid combustion. Some experiments are recorded in which, by spraying in the open with a pressure of 4000 lb. per square inch, fine "needles" of oil were produced which passed through a flame without being ignited. At a little distance the "needles" began to look "fluffy," and then expanded into a cloud which floated away. This cloud ignited with a "smack," producing a large sheet of flame. In compressed air the "needles" would undoubtedly break up more rapidly.

As is well known, there are two methods of injecting oil, namely, air injection and mechanical injection—also called solid injection. The former has the disadvantage of requiring an air compressor, but introduces oxygen with the oil, producing probably a small initial explosion, together with an air blast which causes turbulence and drives the oil into all parts of the combustion chamber. The expansion of the air cools the jet by some 100 deg. Fah., which has to be allowed for by a higher initial pressure of the air in the cylinder. Further, the air compressor reduces the effective horse-power of the engine more than the mechanical injector. The air injector is able to impart greater energy to the atomised oil, to which is probably due the fact that a greater I.M.E.P. is possible with air than with mechanical injection. Thus Engineer-Commander Hawkes has found that with a high-speed engine he could obtain with either a four-stroke or a two-stroke opposed-piston engine 130 lb. per square inch I.M.E.P. with air injection, and only 100 lb. with mechanical injection, using Texas oil fuel in both cases. The cooling effect of air injection is especially noticeable at light loads, and may cause misfires and explosion pressures. The mechanical injection is much freer from these troubles. It would appear that at present the economical results per indicated horse-power are better with air injection than with mechanical.

The more nearly perfect combustion is attained early in the stroke, the better will be the oil consumption of the engine. Departure from perfect combustion is probably the main cause of the difference of oil consumption of various types of engines per indicated horse-power, and it is interesting to estimate—if only approximately—what would be the oil consumption if the combustion were perfect.

In the ideally perfect "constant-pressure admission constant-volume exhaust" engine, it may be taken that, with a compression ratio of 13 to 1, 51 per cent. of the heat due to combustion is rejected in the exhaust and there are no losses.

Estimating that the unavoidable losses in an actual engine as 10 per cent., the efficiency ratio would be 90 per cent. with perfect combustion. To take a numerical example, assume a fuel oil of 19,500 B.Th.U. per lb. gross value; then the heat convertible into work in the cylinder is $19{,}500\ (1 - 0.51) = 9555$ B.Th.U. per lb. Hence the oil consumption per indicated horse-power with perfect combustion and an efficiency ratio of 90 per cent. would be—

$$\frac{2545}{9555 \times 0.9} = 0.296 \text{ lb. per hour.}$$

With a brake efficiency of 75 per cent., which is normal with a four-stroke engine, the oil consumption per brake horse-power would be 0.395 lb. per hour.

TEMPERATURE STRESSES.

The high temperatures and pressures occurring in heavy-oil engine cylinders cause stresses which are difficult to meet. The parts principally affected are the cylinder head, the cylinder walls and the piston. Although special grey cast iron is sometimes used for cylinder heads, cast steel is generally employed because the same strength can be obtained with much thinner walls, which substantially reduces the temperature stresses.

The effect of temperature on the cylinder is the next matter to consider. Its walls are exposed to the usual ring tension due to internal pressure, and also to temperature stresses. The pressure, and consequently the ring tension, is of a fluctuating character, varying from a maximum to nothing. In the case of large cylinders with thick walls, the temperature stresses exceed the ring stress, and if the temperature gradient is considerable the total stress can exceed the elastic limit. The temperature stresses, which are compressive at the combustion surface and tensile at the jacket surface, have been investigated by Lorenz and Lamb. A formula has been devised to calculate these stresses, and shows that they are at maximum at the top of the cylinder close to the head, and diminish rapidly towards the bottom. Consequently, the cylinder walls are made thick at the head and gradually taper towards the bottom. A point which until comparatively recently has escaped notice is that, whereas the ring tension diminishes practically proportionately with the increase of thickness, the temperature stress increases with increase of thickness; so that with large cylinders little is gained by increasing the thickness of the cylinder walls.

To appreciate the temperature difference that has to be dealt with, it is to be observed that the jacket cooling water usually has a temperature of about 80 deg. Fah., except in the case of the Still engine, where the temperature is about 350 deg. Fah., being under pressure. The temperature of the metal just inside the skin in contact with the water is probably some 20 deg. to 60 deg. higher, owing to skin resistance, and also to any deposit from the water. On the combustion side, the temperature at the top of the cylinder varies from about 2000 deg. Fah. at combustion, to about 300 deg. Fah. at the end of the stroke, but owing to the heat transfer resistance of a gas film of about 0.003in. thickness added to the heat resistance of the skin of the metal, the fluctuations of temperature just inside the metal on the combustion side are small, probably not exceeding 40 deg. Fah. There is probably no perceptible change of temperature 0.2in. below the surface; practically therefore the heat gradient in the metal may be regarded as constant for any particular case. The gradient may be much as 125 deg. Fah. per inch, but for usual practice 100 deg. Fah. may be taken.

To give some idea of the relative ring and temperature stresses the following may be quoted from remarks made by Mr. A. D. Bruce in the discussion of a paper read before the Institution of Engineers and Shipbuilders of Scotland. The calculations are made for the 40in. cylinder of a (? projected) German submarine engine of 3000 brake horse-power, and the results are as follows:—

Stresses: Pounds per Square Inch.

Tension due to	Thickness of cylinder wall. 2in.	3½in.
Ring stress	5,000	2,800
Temperature stress	10,630	18,600

The pistons are next to be considered, and temperature affects their design profoundly. Hopkinson has shown that in a gas engine with a piston of 11½in. diameter without water or oil cooling the temperatures stress of tension at the outside rim amounts to 7½ tons per square inch; and thus it is that, for larger diameters, cooling arrangements have to be adopted; and even these arrangements have not—except in experimental engines—been successfully applied to pistons exceeding 33in. in diameter. The maintenance of a flow of oil or water to the underside of the heated surface of a piston is not an easy matter, and special care has to be taken in the design to eliminate pockets where vapour or steam might be produced, which would prevent the cooling fluid being always in contact with the metal. These difficulties are obviously accentuated in the case of double-acting engines and in those of the two-stroke cycle. The means of conducting the cooling fluid either by telescopic or by articulated pipes cannot be regarded as mechanically sound, and any leak, if oil is used, is costly, and if water, is detrimental by interference with the lubrication of crank shaft and other bearings. The quantity of oil in circulation is very large. Salt water must not be used, so that in the case of marine engines fresh water has to be carried for the purpose. Somewhat extensive arrangements have to be provided for cooling the circulating fluid, whether oil or water.

Although one of the greatest difficulties with heavy oil engines is the temperature stress due to the heat flow to the jackets, it is remarkable how small that heat flow is. Thus, in the case of a two-stroke engine, it is only about 0.3 B.Th.U. per stroke per indicated horse-power.

SUPERCHARGING.

A large M.E.P. is desirable to reduce the weight of and the space occupied by the engine and is obtainable by increasing the weight of oil injected per stroke if arrangements are made for reasonably perfect combustion. This requires an increase of oxygen packed into the compression space, and is known as supercharging. Recently the method has been successfully worked in this country, in the United States of America, and by Professor Rateau, to obtain higher powers with aeroplane engines at high altitudes. It is also being adopted for motor car engines.

Other things being equal, the weight of oxygen in the compression space at the moment of oil injection varies directly as the absolute pressure at the moment compression begins. This pressure is generally about 13 lb. per square inch; hence, if supercharged to 4 lb. per square inch above atmosphere, the increase in oxygen content would be as $(14.7 + 4)$ to 13, an increase of 44 per cent. It has been estimated that about 50 per cent. more indicated power may be obtained by supercharging, but a deduction must be made for the power required for supercharging of 10 per cent., leaving a net gain of 40 per cent. The provision of the supercharging plant adds to the capital cost.

It cannot be said that supercharging has advanced very far at present, except in two-stroke engines; but it may be expected to produce great improvements in the future. It must not be forgotten that the temperature stresses are increased.

SCAVENGING.

Scavenging presents a very difficult problem, imperfectly solved at present. The best scavenging is obtained when the scavenge valves are placed in the cylinder cover, but they complicate that casting. If, on the other hand, they are placed at the bottom of the stroke and uncovered by the piston, it is difficult—if not impossible—to obtain a perfect removal of the exhaust gases, even with a carefully designed piston head.

EXPLOSION PRESSURE ("DETONATION").

At one time the statement that "detonation"—or rather explosion pressure, as it should be called—occurred in heavy-oil engine cylinders was greatly resented, but it is now generally accepted, and with its acceptance means for removing, or at any rate reducing, its effects are being proposed.

Detonation is not the right word to use in this case, because what really occurs is an explosion of the same nature as happens in an explosion internal combustion engine (constant volume cycle), but the pressure reached is much higher. The difference between explosion and detonation is the difference between the behaviour of black powder and dynamite. In a heavy-oil engine working under the cycle of constant pressure admission, and constant volume exhaust, a leaky fuel admission valve, or a misfire, or too good a mingling of the fuel in respect of the oxygen, coupled with too early ignition may lead to an explosion, and the heat admission may take place at constant volume. It is easy to show that in the latter case and with a compression ratio of 13 to 1, the maximum pressure may be more than 1300 lb. per square inch, even with a "mixture strength" of only 45 B.Th.U. per cubic foot. With a heavy leak the maximum "mixture strength" may be reached, and then the explosion pressure may be as much as 4000 lb. per square inch.

It is not likely in practice that leakage or misfire will produce a perfect explosive mixture, so that the extreme pressures indicated above are not likely to occur; but very high pressures are reached and are shown on "displaced" indicator diagrams.

It is clear that if such high pressures occur frequently they will have a disintegrating effect on the engine; but in any case allowance must be made for those pressures by increasing the scantlings, especially those

* The "James Forrest" Lecture, 1925. Abridged.

of piston-rods, connecting-rods and crank shaft, thus adding to the weight of the engine.

In order to ensure self-ignition, the temperature must not be less than 700 deg. Fah. for ordinary heavy oils, practically irrespective of the pressure. If, therefore, the air is heated otherwise than by compression, a lower pressure will suffice and a lower compression can be adopted. Thus in the Still engine the air is heated during compression by the hot jacket water (temperature about 350 deg. Fah.). It is found that the compression ratio can be reduced to 9 to 1, and the maximum explosion pressure for this ratio is about 800 lb. per square inch, a very great improvement. With an ordinary heavy-oil engine the danger of misfire is greatest at starting owing to the cold cylinder walls.

It is probable that air injection of fuel is more liable to cause explosion than mechanical injection.

Materials Used.

Ordinary carbon steel is generally used for crank shafts, connecting-rods and piston-rods; the specially heat-treated steels adopted in high-speed petrol engines, for the sake of lightness, have not, up to the present, been largely adopted for heavy-oil engines, but their use will probably be considered in the future to reduce the weight of the engine.

Until recently cast iron of special mixture has been used for cylinder liners and pistons, but trials are now being made with forged steel for cylinder liners and aluminium alloys for pistons.

Steel castings for cylinder heads are specially suitable for two-stroke engines, the castings being comparatively simple. Steel has greater elasticity to resist deformation than cast iron.

The usual material for cylinder walls or liners is cast iron, but of a special quality, and the same may be said about pistons. Recently there was a conference on the subject by the Local Section of the Institution of Mechanical Engineers and the Institute of British Foundrymen at Glasgow. The requirements, the difficulties in finding suitable mixtures and in producing the castings, were fully discussed, and the continental and British practices were compared.

The weight of cast iron pistons has led to the adoption of aluminium alloy in some cases. Such pistons are universally used in aircraft engines and in many motor-car engines, for lightness, to reduce inertia forces and thereby to make very high speeds possible. The same consideration applies to high-speed large heavy-oil engines—300 revolutions per minute and over—and such pistons are used for this reason by Messrs. Fraser and Chalmers. Engineer-Commander Hawkes has experimented with them for the same reason, and states that their adoption up to a diameter of 20in. is warranted in the Navy. He also states that the inertia forces with these pistons at 500 revolutions per minute are the same as those at 380 revolutions per minute with ordinary cast iron pistons.

The aluminium alloy has the further advantage that it is a better conductor of heat than cast iron, but it has the disadvantage of greater heat expansion, requiring a 50 per cent. greater clearance between the piston and the cylinder walls.

Weight.

The heavy-oil engine of to-day suffers greatly from excessive weight; in the case of land engines the disadvantage is mainly a question of cost, which approximately increases proportionately to the weight; but in the case of the marine engine, in addition to cost, there is the great objection of the additional weight to be carried and of the additional space required. If a comparison be made with a steam installation using turbines, the weight and space occupied by the steam-generating plant must be taken into account on the one hand, and the accessories for the oil engine on the other; such, for example, as the air-bottles for starting and manœuvring purposes. Such a comparison has resulted sometimes in favour of the steam plant.

It is imperative that great reduction in the weight of heavy-oil engines for marine purposes be made without undue delay, so that engines of 2000 to 5000 brake horse-power can compete with steam plant. Beyond the latter power the steam turbine will undoubtedly hold the field until the oil turbine is a practical proposition, or some marked improvement in construction is devised. The four-stroke single-acting engine is obviously the worst offender, the reason being the great ratio of maximum pressure to mean pressure, the provision to be made for explosion pressure, and to the alternating stresses acting on the crank shaft. The two-stroke engine is better because the ratio of maximum to mean pressure is approximately halved; but the best of all is the double-acting two-stroke engine in which the ratio of maximum to mean pressure approximates to that of a steam engine, and the crank shaft is not exposed to alternating stresses, though there still remains the possibility of explosion pressure.

The following figures for a single-cylinder gas engine of 600 brake horse-power, having a stroke of 51in. and running at 90 revolutions per minute, give an idea of the improvement indicated above and a comparison with a steam engine.

Type.	Diameter of piston. In.	Weight of reciprocating parts. Lb.
Single-acting four-cycle	47½	11,200
Double-acting four-cycle	33¾	7,500
Double-acting two-cycle	23¾	3,750
Steam engine—condensing	29½	3,300

A great reduction in the weight of reciprocating parts can be effected by increasing the revolutions, but this method is, to a certain extent, denied to the marine engine on account of the propeller, which loses in efficiency as the revolutions increase. A possibility is to run the oil engine at a high speed, say, 300 revolutions per minute and over, and reduce the propeller-shaft speed by helical gearing, as is done, for example, in the case of steam turbines. The method has been tried with good results.

Another cause of heavy weight at present is the comparatively small power obtainable per connecting-rod, even with a double-acting engine, so that for a large engine a multiplicity of cylinders have to be used. The reported success of experimental engines with cylinders of larger diameter than hitherto used is hopeful for the future. A motor ship with twenty-four cylinders, as in the case of the Aorangi, is probably a transitional phase.

Table I. gives some weights of engines for comparison. As secondary possibilities for reducing weight, the following may be stated: The employment of lighter and stronger materials, increase in indicated M.E.P., and reduction in friction losses. As regards the latter, the friction losses with a four-stroke engine are about 25 per cent. of the indicated horse-power, whereas with a double-acting two-stroke engine, they should not exceed, say, 15 per cent. This improvement alone would result in nearly 12 per cent. reduction in weight reckoned on the brake horse-power.

Table I.

Name of engine.	Type of engine.	B.H.P.	No. of cylinders.	R.p.m.	Total weight. Tons.	Weight per B.H.P. Lb.
Beardmore-Tosi (T.S. Sycamore)	Four-stroke single-acting	1,250	6	125	225	404
Fraser and Chalmers	Four-stroke single-acting	2,000	8	300	172	194
Nobel (T.S. Zoroaster)	Two-stroke single-acting	1,600	4	100	175	247
Sulzer	Two-stroke single-acting	5,400	6	80	625	255
Scott-Still (T.S. Dolius)	Two-stroke single-acting, steam on underside of piston	1,250	4	125	157	282
Doxford	Two-stroke opposed pistons	3,000	4	77	350	260
Worthington	Two-stroke double-acting	4,000	4	90	270	150
"Estimated"	Two-stroke double-acting	12,000	6	80	750	142

Lubrication.

The lubrication of the cylinders and of the moving parts is of great importance, and to-day the amount of oil used is excessive, so that means should be found for a substantial reduction. The kind of oil used for cylinder lubrication, especially with two-cycle engines, still requires research to arrive at the best results. This research is not easy, because it is difficult in a laboratory apparatus to reproduce the conditions obtained in the cylinder, and, incidentally, it is difficult to devise "acceptance tests" for such oils. The tendency of lubricating oil is to carbonise, and thus produce hard deposits which jam the piston rings and score the cylinder liners. At present the best way is to specify a particular brand of oil and to depend on the oil merchant—not a satisfactory proceeding—so that better knowledge is obviously required. What effect viscosity has is still uncertain.

The places where oil is introduced into the cylinder require much care in selection, especially in two-stroke engines. Somewhere near the exhaust and air ports, that is, about midway down the cylinder, is probably best; but if care is not taken, the oil will be blown out through the exhaust ports. The apparently insignificant fact of chamfering the piston for a short distance below the scraper ring and the lower ring, and by providing at those positions relief holes to the inner side of the piston, has been shown to reduce the cylinder lubrication from 4 or 5 per cent. of the fuel oil to 1½ per cent.

Utilisation of Waste Heat.

The utilisation of the heat rejected by an internal-combustion engine has, from early days, exercised the ingenuity of engineers. In the case of a gas engine the heat in the exhaust is about 45 per cent. of the heat of combustion of the gas, and has been used in exhaust boilers which give about to 2 lb. to 2.5 lb. of steam per horse-power.

The heavy-oil engine has a better thermal efficiency than a gas engine, and hence there is less heat rejection. Moreover, the temperature of the exhaust is less. The amount of steam produced is small, namely, 0.8 lb. of steam for a four-stroke engine, and 0.5 lb. per horse-power for a two-stroke engine. The installation of an exhaust boiler has, therefore, except under special circumstances, no practical value when due allowance is made for capital expenditure and maintenance.

So far only the exhaust gases have been considered, because the heat carried away by the jacket water is at too low a temperature to be useful to obtain power. If, however, the jacket is maintained at a high temperature, the heat therein can be added to that of the exhaust, and a considerable quantity of steam can be produced, so much so that more than 10 per cent. additional power can be obtained from the engine, if the steam is applied to the underside of the pistons of the oil engine in accordance with the Still system.

Conclusion.

In conclusion, I would like to urge the necessity for co-operation in research, and in this connection to offer my appreciation of the work done at the Admiralty Research Laboratory and so freely communicated by Engineer-Commander Hawkes and by Engineer-Commander Beeman in their papers read before the Institution of Naval Architects. The object of the trials therein described is to obtain a powerful high-speed engine of light weight for naval purposes.

For the merchant marine a low-speed engine of much greater power than at present possible is needed, and of lighter weight per brake horse-power.

This may be regarded as *the* outstanding question, but before it can be answered the subsidiary problems discussed in this lecture will have to be solved satisfactorily.

Fifty Per Cent. Cut-off Locomotives.

PENNSYLVANIA RAILROAD SYSTEM.

By E. C. POULTNEY, O.B.E.

PART I.

Introductory Remarks.

In December, 1916, a large "Decapod" 2–10–0 type locomotive, No. 790, was built at the Juniata Shops, Altoona, Pa., under the direction of Mr. J. T. Wallis, Chief of Motive Power, for service on the Pennsylvania Railroad system. It was designed for heavy goods train operation, and with the idea of providing about 25 per cent. more tractive effort than that furnished by the existing "Mikado" 2–8–2 type locomotive, Class L 1 s.

In view of the fact that goods locomotives when handling maximum loads often work for considerable periods of time at rates of cut-off at or near the end of the stroke, and that such working was specially the case in "assisting" or "helper" service on heavy gradient sections, it was decided to design the new locomotive in such a manner that the maximum rated tractive effort could be obtained with a cut-off not later than 50 per cent. in place of the usual 90 per cent. common in practice. The idea underlying this principle of working is the elimination of those points of cut-off at which the steam rates per unit of power are excessive. Observations on the testing plant and in road tests had shown that the lowest steam consumptions at speeds usual in service were those obtaining between minimum rates of cut-off up to 50 per cent. In other words, it was appreciated that if the new engines could be designed to work at a maximum cut-off of 50 per cent. without any sacrifice of drawbar pull compared with an engine working at about 90 per cent., then for a given power there might reasonably be expected a saving in water consumption and in fuel equal to the difference between the relative consumptions at 90 per cent. and 50 per cent. rates of admission, or approximately 25 per cent. Evidently, in addition, a relatively greater economy in fuel might be possible because if, on the one hand, for the 50 per cent. cut-off locomotive the same sized boiler was used as would be considered necessary for an ordinary locomotive, then the fuel saving would be proportionately greater, and furthermore, on the other hand, if a smaller boiler were employed, proportioned for the 25 per cent. less steam required for a given power output, then, if expedient, a somewhat lighter locomotive could be obtained.

Broadly, the above is an outline of the development and principle of this particular locomotive design, and this article, which has been prepared with the assistance of drawings, photographs, and other aid most courteously furnished by Mr. J. T. Wallis, Chief of Motive Power, Pennsylvania Railroad system, has been written in the belief that particulars of these interesting locomotives, together with information relative to the results obtained with them, may be of practical interest.

"Decapod" and "Mikado" Type Locomotives.

The new "Decapod" type, 50 per cent. cut-off locomotives forming the subject of this article will be compared with the former 2–8–2 or "Mikado" type goods engines; some particulars, therefore, will be given concerning the latter, one of which is illustrated by Fig. 1. The "Mikados" have been in service now for some time, having been introduced nine or ten years ago. They were built at the Juniata shops to meet the requirements of Mr. Wallis, and the desire to provide a much more powerful type of locomotive

than the existing "Consolidations," Class H 9 s, having cylinders 25in. by 28in., 3839.1 square feet of combined heating surface (water side of tubes and flues), a tractive effort of 49,000 lb., and a total weight (engine only) of 251,050 lb.

The "Mikado" class L 1 s goods locomotives, like the "Pacific" passenger locomotives, Class K 4 s, when first introduced, attracted considerable attention, embodying as they did features constituting a step forward in locomotive designing, for besides being notable for their large capacity, great care was taken in the proportioning of the boiler and fire-box and in the weight distribution. In the design, also, of the motion parts every care was taken to keep down the weights of the revolving and reciprocating masses, and heat-treated alloy steel was used for the piston-rods, connecting and coupling-rods, crank pins and valve gear details, thus following a practice already proved successful with the E 6 s "Atlantics" (new type) and the K 4 s "Pacifics" above mentioned—see THE ENGINEER, June 6th, 1919.

Compared with the "Consolidations," the "Mikados" are 25.7 per cent. heavier (engine only in each case), have 25 per cent. greater tractive effort, and have but a 7.2 per cent. increase in the weight on the coupled axles; the adhesive factors being 3.91 and 4.56 for the "Mikados" and "Consolidations" respectively; the engine weights per square foot of combined heating surface (water side of tubes and flues) are for the "Mikados" 62.0 lb. and for the "Consolidations" 65.4 lb., indicating a lighter engine in proportion to the available power.

The "Decapod," or 2–10–0 design, adopted to work with a maximum cut-off in full gear of 50 per cent., is illustrated by Figs. 2 and 3. In developing the engines of this type certain features required attention, the principal of which may be mentioned. As the cut-off takes place so much earlier than usual in the stroke, it follows that provision must be made to increase the mean steam pressure, the average pressure for any given initial pressure being much less than that obtainable with a 90 per cent. cut-off. This can be accomplished by increasing the cylinder

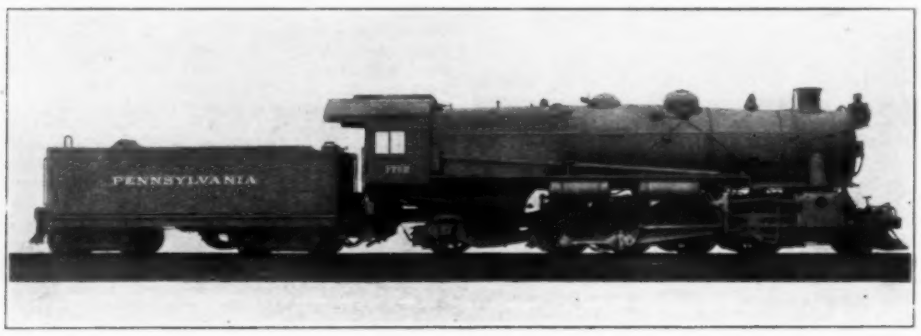


FIG. 1—"MIKADO" TYPE GOODS ENGINE

diameter or by raising the boiler pressure, or by both in combination. Obviously, also, the cylinder volume may be enlarged—*i.e.*, both the diameter and stroke increased—together with the same or higher steam pressure.

In so far as the cylinders are concerned, certain difficulties present themselves when a considerable increase in size is contemplated. Of these perhaps the one most readily recognised is the limitation in over-all width of engine. There is, however, another factor to be considered; it is the length of the stroke. Stroke is limited by the diameter of the driving wheels, and must be such that proper clearances are obtained when the throw of the main cranks are on their bottom centres. Another matter of importance which has to be considered is the starting, for it will be evident that with so early a cut-off as 50 per cent. the locomotive might very easily come to a stand with the cranks in such a position as to make starting again difficult. To overcome this, auxiliary steam ports of small dimensions are cut in the valve liners, one for the main port at each end of each cylinder, and so placed in relation to the main ports that an actual cut-off of 80 per cent. is available. These supplementary ports are in action all the time the engine is moving with steam on, but they are so small that, while they permit of steam entering the cylinders at starting, yet at the same time their effect on the indicator diagram is largely neutralised owing to wire-drawing at about 2.5 miles per hour and at ordinary speeds the steam entering through them is entirely negligible. The arrangement and dimensions of the starting ports and their relation to the main ports and to the valve is well shown by Fig. 4, and needs, therefore, no further explanation. The appended table gives the principal dimensions of the "Mikado" Class L 1 s and the two "Decapod" types, Class I 1 s, as built in 1918 and 1922. The chief alterations consist in fitting a type "E" superheater in place of the usual type "A" to the latter locomotives, 1922 series, which are also equipped with a Worthington open type feed heater. An illustration of the first 2–10–0 engine, No. 790, Class I 1 s, will be found on page 447 of THE ENGINEER, April 21st, 1922.

Before describing the 50 per cent. cut-off locomotives now in successful operation on the Pennsylvania system, more detailed reference is necessary to the general principles of the design of locomotives working on this system. In this connection reference will be made to a very complete paper on the subject of "Fifty Per cent. Cut-off Locomotives," read before the New York Railroad Club by Mr. W. F. Kiesel, jun., mechanical engineer, Pennsylvania Railroad system, in November, 1923.

It has already been explained how the restricted cut-off locomotive differs from those of the ordinary type, and that the locomotives under notice were developed in accordance with knowledge gained from the test plant and on road trials. From experience with simple expansion locomotives, the following observations are made:—

The lowest steam rates are those obtaining between about 20 per cent. and up to 50 per cent. cut-offs. For starting at least an 80 per cent. cut-off is required in two-cylinder engines. The power of a locomotive is dependent on the cylinder volume, the mean effective piston pressure, and the diameter of the driving wheels.

The usual formula $\frac{D^2 \times L}{W}$ gives the tractive force per pound of mean effective pressure, D being the cylinder diameter, L the strength of the stroke, and W the diameter of the driving wheels. The boiler pressure P, multiplied by the coefficient C, gives the mean pressure. C depends on the ratio of expansion E. Based on tractive effort at the cylinders, not at the drivers, E for 90 per cent. cut-off is equal to 1.111, and C, being equal to $\frac{2}{E+1}$, is therefore equal to $\frac{2}{1.111+1} = .947$, so that $\frac{D^2 \times L}{W} \times P \times .947 =$ the tractive force at the cylinders of a two-cylinder locomotive having a 90 per cent. cut-off in full gear. In a similar manner, for 80 per cent. cut-off, $E = \frac{100}{80} = 1.25$, and $C = \frac{2}{1.25+1} = .889$, and for 50 per cent. cut-off, $C = .667$.

These values are reduced by 10 per cent.—by some authorities 8 per cent.—when the tractive effort at the drivers is required. Approximately, the relative indicated tractive powers of 90 per cent. and 50 per cent. cut-off locomotives, having equal cylinder volumes, driving wheels and steam pressures, are as follows:—For the 90 per cent. cut-off locomotives the tractive effort at starting is 0.947, and at about 12.5 miles per hour (62in. drivers) 0.85. For the 50 per cent. locomotive the tractive effort at starting is 0.889. It is 0.80 at 2.5 miles per hour and 0.666 at about 12.5 miles per hour.

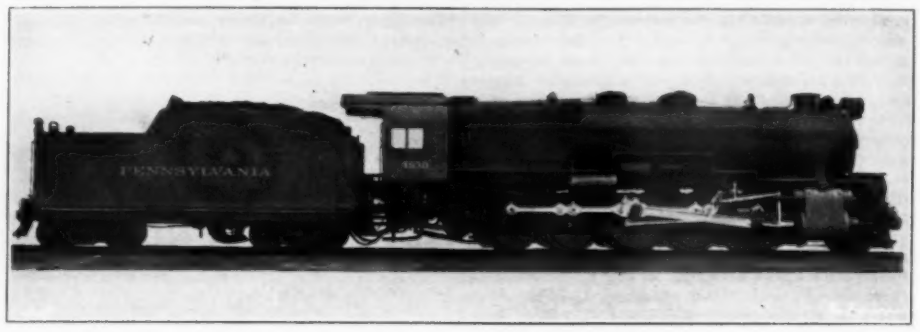


FIG. 2—"DECAPOD" ENGINE FOR HEAVY GOODS SERVICE

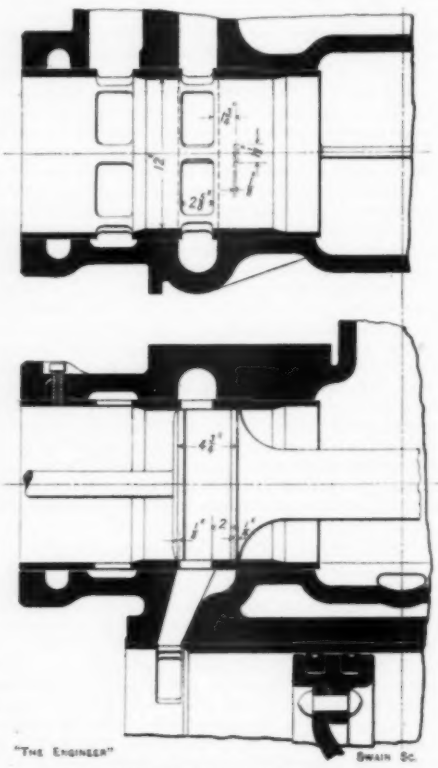


FIG. 4—ARRANGEMENT OF STARTING PORTS

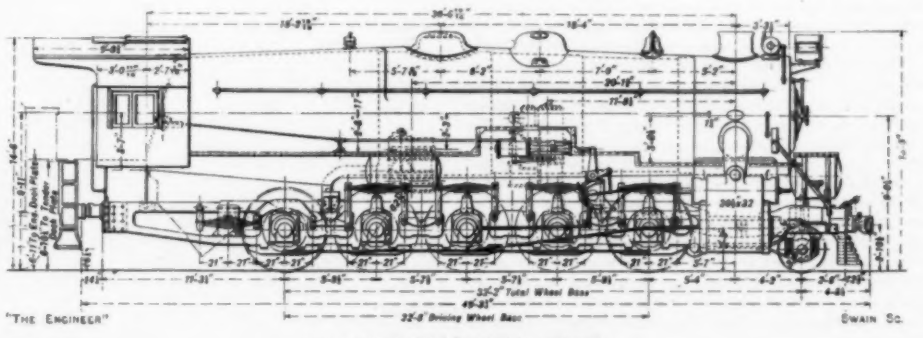


FIG. 3—"DECAPOD" GOODS ENGINE

Based on the results obtained at 12.5 miles per hour, the increase in the value of the engine constant $\frac{D^2 \times L}{W}$, or in the value P × C, must for the 50 per cent. cut-off locomotive be 27.6 per cent., shown by the relationship between 0.85 and 0.666, as follows:—

$$\frac{0.85 - .666}{.666} \times 100 = 27.6 \text{ per cent.}$$

In the paper above referred to, Mr. Kiesel says that the increase should not be less than 25 per cent., which in practice seems from the data given—relative to the performance of locomotives with equal cylinders and driving wheels, but in one case 200 lb. and in the other 250 lb. steam pressure—to give very closely equal powers. Assuming the 50 per cent. cut-off locomotives to have pistons 25 per cent. greater in area than the long cut-off engines, so that the piston pressures are for a given steam pressure 25 per cent. more, then, other things being the same, the following relative conditions will obtain.

TABLE I.—*Pennsylvania 2-10-0 and 2-8-2 Type Locomotives: Comparative Dimensions.*

	2-8-2.	2-10-0. 1918.	2-10-0. 1922.	Ratio, 2-10-0. 2-8-2 1918.
Weight, engine, lb. ..	320,700	371,800	386,100	1.159
Weight on drivers, lb.	240,200	341,800	352,500	1.423
Wheels—				
Drivers, dia., in. ..	62	62	62	
Leading truck, dia. in.	33	33	33	
Trailing truck, dia. in.	50	—	—	
Cylinders: No., dia. and stroke, in.	27 × 30	30½ × 30	30½ × 30	1.361
Valves, dia., in.	12	12	12	
Boiler steam pressure ..	205	250	250	1.22
Tubes: No., dia., outs.	236—2¼	244—2¼	114—2¼	
Flues: No., dia., outs.	40—5½	48—5½	200—3½	
Length between tube plates	19ft.	19ft.	19ft.	
Heating surfaces—				
Tubes, water contact	2623.5	2730.0	1275.7	
Flues, water contact	1092.24	1313.94	3232.3	
Fire-box, including arch tubes, fire contact	301.51	290.20	292	
Total evaporative ..	4017.22	4334.14	4800	
Superheater, fire contact	1171.63	1478.91	2469	
Total combined ..	5188.85	5813.05	7269	1.119
Grate area	70.0	69.89	69.89	
Tractive effort, lb., at 85 per cent. boiler pressure for 50 per cent. C.O. 80 per cent	61,500	96,000	96,000	
Superheater type ..	Type A	Type A	Type E	
Feed-water heater ..	None	None	Worthington	
Stoker	None	Duplex	Duplex	
Max. I.H.P.	2,837	3,486		1.230
Coal, B.Th.U.	13,989	13,425		0.959

At starting the 50 per cent. cut-off locomotive will be the more powerful because the relative starting efforts at the cylinders will be—

$0.947 \times 100 = 9.47$ for 90 per cent. cut-off
$0.889 \times 125 = 11.11$ „ 50 „ „

and at about 12.5 miles per hour the relative indicated tractive efforts will be—

$0.85 \times 100 = 85.0$ for 90 per cent. cut-off
$0.666 \times 125 = 83.2$ „ 50 „ „

ADVANTAGES AND DISADVANTAGES.

Having shown how the 50 per cent. locomotive differs in its inherent features from the ordinary engine, it may be well to draw attention to these characteristics with the idea of apportioning to each their advantages and possible disadvantages, since it is not unusual to pay for certain advantages in any mechanism by certain drawbacks.

(*a*) Generally the 50 per cent. cut-off locomotive may be described as one which in expansion ratio approximates to the compound in uniformity of torque, practically equals the three-cylinder engine, and in simplicity is the same as a two-cylinder locomotive of normal construction.

(*b*) It involves no mechanical complications. The additional features required are merely the provision of the small auxiliary ports in the valve bushings. These ports are the only features directly necessary, and consequent to the 50 per cent. cut-off principle.

(*c*) As engines designed on this system are intended to do most of their work at 50 per cent. cut-off, maintenance costs, it is claimed, need be, owing to uniformity of torque, no greater than for an ordinary engine.

(*d*) No additions are necessary to the valve motion, the only change required being an alteration in the ratio of the lap and lead levers (Walschaerts' gear) to suit the increased steam lap.

(*e*) The piston loads at starting (not at speed), compared with the ordinary type of engine, will be much higher. For equal power and for equal strokes and driving wheel diameters, the starting piston pressure will be at least 25 per cent. greater. The increased piston loads will call for proportionately heavier revolving and reciprocating parts, hence greater counterbalance is required. The increase in the size of the main crank pins, the crank pin ends of the connecting-rods, and in the crossheads and piston-rods, constitute factors in the design of a negative nature, and therefore require careful consideration.

(*f*) No modification is required in the coupling rods, since they, being designed in proportion to the adhesive weight, need be no heavier because the weight on the coupled axles for a given power need not be greater.

(*g*) The proportional increase in the weights of the motion will depend on the type and size of locomotive considered. For a heavy Mikado of 320,000 lb. (143 long tons) the increase is estimated at about 1.125 per cent. of the total engine weight. The increase in the reciprocating weights is important. For slow speeds it is argued that it is of small importance, but for high speeds it assumes considerable importance. For fast passenger service it may be assumed that the negative effect of the increase of the reciprocating weights balances the positive effect of the estimated 10 per cent. economy obtainable in fast services. On the other hand, for slow-speed service the negative effect of the heavier parts is subservient to the savings in fuel and water. These may be about 25 per cent.

As previously mentioned, the torque of the 50 per cent. cut-off locomotive is almost as uniform as that of a three-cylinder engine. A comparison of the maximum to minimum tangential pressures of three-cylinder and two-cylinder engines, both cutting off at 50 per cent., resulted in a ratio of 126.25 for the former and 126.66 per cent. for the latter, and a similar analysis of the pressures for two-cylinder engines having 90 per cent. and 50 per cent. rates of admission showed ratios of 158 per cent. and 131 per cent. for each respectively. Hard-and-fast rules cannot, of course, be made owing to the influence of the relative lengths of the connecting-rod and crank arms.

FUEL AND WATER CONSUMPTIONS.

In full gear working it is evident that the steam consumption for the 50 per cent. cut-off locomotive will be $\frac{1.25 \times 50}{90} = .694$, which means a saving of 30.6 per cent., and that a boiler having an evaporative value of something approaching 30.6 per cent. less than that required for an ordinary locomotive will meet requirements.

If the same sized boiler is retained then the saving in fuel will be greater (in per cent.) than that realised in steam consumption. The water saving indicates that for the same train the 50 per cent. cut-off engine working in full gear can travel 44 per cent. further before stopping for water. In computing the fuel savings the size of the boiler must be allowed for, since the larger the heating surface the greater will be the water evaporated per unit of coal fired.

Tests made with the 2–10–0 50 per cent. cut-off locomotive showed that the ratio of water evaporated to coal fired could be expressed by

$$W \div C = 10.622 - .000104125 \times W,$$

where W = evaporation lb. per hour, and C = coal fired lb. per hour.

The 2–8–2 "Mikado" type engines, Class L 1 s, have a total combined heating surface of 5188.85 square feet, and for the 2–10–0 50 per cent. cut-off locomotive tested this figure is 5813.05 square feet, or 11.9 per cent. more for the 2–10–0 engine.

These two engines may be compared for evaporations per unit of coal by the formula above mentioned, for the reason that the coefficient of the second term will vary inversely as the value of the heating surfaces. For comparison the formulæ are then:—

For the ordinary locomotive:
$$W \div C = 10.622 - .000104125 \times W;$$
For the 50 per cent. cut-off locomotive:
$$W \div C = 10.622 - .0001167 \times W.$$

If W = 50,000 for the ordinary locomotive, then for the 50 per cent. engine W will be 30.6 per cent. less or $\frac{50{,}000 \times .694}{100} = 34.700$ lb., and from the formula W/C for the ordinary engine will be 5.42, and for the latter 6.61, equivalent to a saving for the 50 per cent. cut-off locomotive of 43 per cent. and an increase in the distance run before having to take on fuel of no less than 75 per cent.

These comparative consumptions represent the extreme economy obtainable, and are results which cannot be realised as an average in any service with the single exception of perhaps shunting service, when both engines would be operated in full gear.

TESTING PLANT RESULTS.

The Decapod locomotive, No. 790, Class 1 L s, 1918 series, was tested on the plant at Altoona some few years ago, and the results reported in the Test Department Bulletin No. 31. The leading particulars of the two types have already been given in Table I. The results given do not apply to tests made at less than 30 per cent. of the maximum water rate of the boilers. The average water rate per pound of dry coal fired from the tests of the 2–10–0 is:—

$$W/C = 10.622 - .000104125 \times W.$$

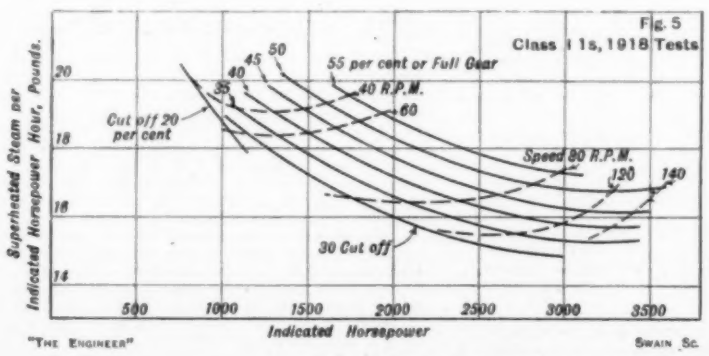
This formula tabulated gives values as follows:—

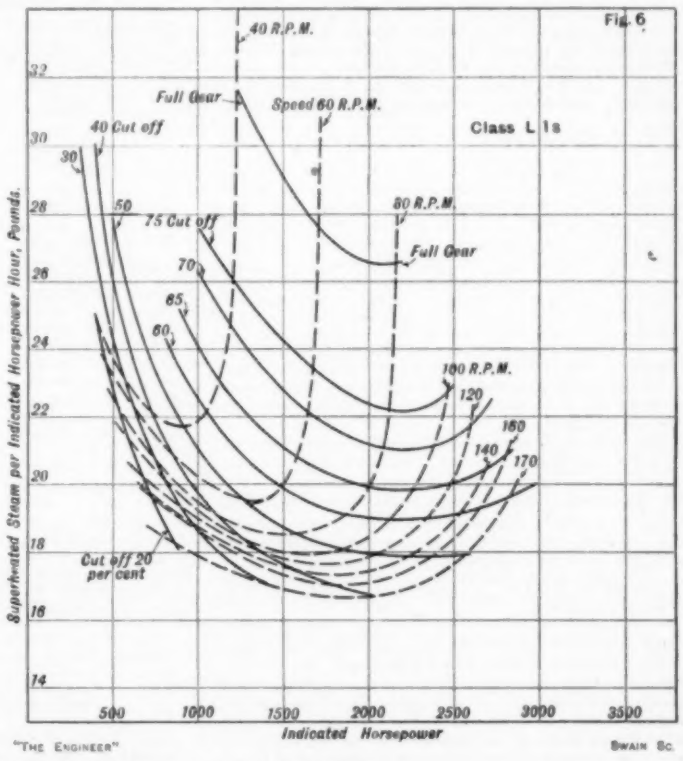
Water, lb. per hour.	W ÷ C.
20,000	8.54
30,000	7.50
40,000	6.46
45,000	5.94
50,000	5.42
55,000	4.90
60,000	4.38

Figs. 5 and 6 taken from Bulletin No. 31 give respectively the water rates at all cut-offs and for speeds varying from 40 to 140 revolutions per minute in the case of the 2–10–0 engine and from 40 to 170 revolutions per minute for the 2–8–2. The speeds in miles per hour for each locomotive are 7.38 at 40 revolutions per minute and 25.83 at 140 revolutions per minute.

The following remarks should be noted:—Referring to Fig. 5, the line marked 55 per cent. cut-off is so designated because it represents a higher mean effective pressure than would be obtained at a 50 per cent. rate of admission. From Fig. 5 it will be seen that the maximum water rate for the 50 per cent. cut-off engine is 19.5 lb., and at the same speed of 40 revolutions per minute Fig. 6 shows that the 2–8–2 requires 31.8 lb. per indicated horse-power per hour. The following results are obtained at this speed, which is the minimum when the evaporation is higher than 30 per cent. of the maximum.

Locomotive.	I.H.P.	W/I.H.P.	Water evaporated per hr.
2–10–0	1,720 ..	19.5 ..	33,540
2–8–2	1,230 ..	31.8 ..	39,114
2–10–0 / 2–8–2	1.40 ..	.613 ..	.857





FIGS. 5 AND 6—WATER RATES AT VARIOUS CUT-OFFS FOR THE 2-10-0 AND 2-8-2 ENGINES

The Protection of Underground Water.

AMONG the Sub-Committees which have been appointed by the Advisory Committee on Water is that which is considering the question of what new legislative provisions are required for the protection of underground water. A report, recently prepared by that Committee, with the assistance of officers of the Ministry of Health, which has been unanimously adopted by the main Committee, has just been made public, and we propose, in what follows, to give a summary of its main features. The Sub-Committee was appointed in October, 1923, and, up to the time of framing its report, had held eleven meetings.

THE NEED FOR ALTERATION OF EXISTING LAW.

The Sub-Committee holds that the present law regarding the abstraction and waste of underground water is, undoubtedly, most unsatisfactory. Whilst it provides safeguards to statutory water undertakers *inter se*, it does not protect those undertakers from loss or diminution of their underground supplies, which results from the exercise by neighbouring landowners, whether private individual, firm or company, of their common law right to abstract the water under their lands. It is pointed out that it is manifestly unfair that statutory water undertakers should be restricted by Parliament or the Central Authority in their choice of sites for wells and pumping stations, and should be compelled in many instances to give compensation for any depletion of neighbouring supplies resulting from their pumping, whilst other industrial undertakings are not subject to any such restrictions or obligations. Moreover, the law fails to secure the individual landowner in the enjoyment of his common law right. He may be deprived of the water under his land, upon which he relies, by the action of a neighbouring landowner, but he has no remedy. The Sub-Committee points out that the constant growth of population, accompanied by a rising standard of sanitation, and the development of industry, involve a greater use of water. It is clear, it says, that the increasing demand for water must result in underground water being drawn upon to a greater extent. The difficulties arising out of the existing law are bound to be multiplied as greater use is made of underground water. The more immediate need is that the underground supplies upon which public water authorities and also private individuals and commercial undertakings depend, should be guaranteed against unreasonable interference. Equally important, it adds, is the necessity for protection, both from interference and contamination, of valuable underground supplies which must sooner or later be drawn upon to meet the water requirements of the country.

Having drawn attention to the various ways in which mining operations may deplete or injure underground water supplies, the report continues :—" Under present conditions, recourse must be had direct to Parliament in particular cases where protection of underground water forming the source of a public water supply is required from interference by private enterprise. Judging from the past, Parliament would readily afford protection in suitable cases, but the procedure involves delay and expense, and is not in practice available to the small water undertakers." In an appendix notes are given of a number of special cases illustrating the need for remedial measures.

SUGGESTED SCHEME OF CONTROL.

Some form of State control is, the Sub-Committee considers, essential in order to remove or mitigate the harmful results of the present system. The measures to be taken should, it suggests, be directed generally towards the protection and conservation of underground water supplies, and in particular to the following :—

(*a*) The control of operations involving the abstraction of underground water forming the supply of existing undertakings, whether public or private, or a potential supply for the future needs of the local community.

(*b*) The prevention of waste of underground water and the provision of better facilities for rendering available for use surplus water which is brought to the surface in connection with mining and other underground operations.

(*c*) The prevention of contamination of underground water.

The Sub-Committee then goes on to suggest that :—(1) It should be made unlawful for any person to commence to :—

(*a*) Construct any well, boring, adit, shaft or other work involving, or likely to involve, abstraction of underground water ; or

(*b*) extend any existing well, boring, or adit for the purpose of abstracting additional quantities of underground water ; or

(*c*) extend or utilise for any purposes, other than those set out in paragraph (2) below, any such well, boring or adit as is mentioned in that paragraph,

unless he has given notice in the prescribed form of his intention to commence the construction, extension or utilisation of such well, &c. (as the case may be), and, if objection is made to the proposal and is not withdrawn, until he has obtained the licence of the Minister of Health.

And (2) that the above prohibition should not apply in the following cases :—

(*a*) The construction or extension of any well, boring, or adit by any private individual for the purpose of abstracting underground water solely and to the extent necessary for a supply of water for domestic purposes as defined in Sec. 12 of the Waterworks Clauses Act, 1863, a supply for a farm and for the stock on a farm, and not for sale or for use in connection with any trade or business other than stock farming.

(*b*) The construction or extension of any well for affording a supply of water to the local inhabitants otherwise than by means of a piped supply.

(*c*) The construction or extension of any well, boring, or adit which has been, or may be, expressly mentioned by an Act of Parliament or by an Order having the effect of an Act of Parliament.

(*d*) Experimental borings required in connection with any of the purposes mentioned in (*a*) (*b*) and (*c*) above, or required for any purpose other than that of obtaining a supply of underground water.

It is further recommended that (3) if the proposal relates to the construction or extension of a well or boring, &c., notice of the intended work should be given not less than four weeks before the work is to be commenced by advertisement in one or more local newspapers circulating in the urban or rural district in which the work is to be situated. The notice should be in a prescribed form. Any local authority, any water undertakers, or any other person who may be affected by the intended work or other proposal described in the notice, should be entitled to object to the proposal by sending notice of objection, stating the ground of the objection, to the Minister of Health within the period allowed, and by sending at the same time a copy of the notice of objection to the person by whom or on whose authority the proposal is made. The Minister of Health should be empowered to grant the licence, with or without conditions, or to refuse the licence, but before he refuses the licence, or grants the licence subject to conditions, he should be required to cause a public local inquiry to be held into the application and any objection thereto. If the licence is required for the purpose of obtaining a supply of underground water for the needs of a particular industry, trade or business, the Minister should not be empowered to refuse the licence or attach conditions to the licence, unless he is satisfied that the public needs for water for domestic purposes will be prejudicially affected. Where the licence is required for the construction of a boring, shaft or other work, for some purpose other than that of obtaining underground water, the Minister should not be empowered to refuse the licence unless he is satisfied that the boring, shaft, or other work will deplete or injuriously affect an underground source of water supply which ought, in the public interest, to be conserved or protected. In any such case the Minister should be empowered to attach conditions to the licence for the purpose of securing that the work is carried out and maintained in such a manner as to prevent the depletion or injury of the underground source of water supply. Provided that the Minister is satisfied that, in all the circumstances of the case, the additional cost entailed by fulfilling the conditions will be justified. In any such case the Minister should also be empowered to attach conditions to the licence in order to ensure that any water brought to the surface through such boring, shaft or other work can, if required, be utilised on reasonable terms for public water supply.

Penalties should be imposed for failure to comply with the more important requirements, such as the construction of the work without notice or licence, as the case may be, or any breach of any condition attached to the licence. It is suggested that a penalty not exceeding £100 should be prescribed in these cases, and that a daily penalty not exceeding £10 should be prescribed in respect of the continued use of an unlicensed work.

The foregoing requirements should, in the Sub-Committee's opinion, only be in force in areas to which they have been expressly applied by Order of the Minister of Health made after public local inquiry. To this point it attaches considerable importance.

The Sub-Committee then proceeds to say that it understands that it is generally the practice to adopt the freezing process or the cementation process during the sinking of a shaft through water-bearing strata, and that these processes are generally effective in securing the minimum injury to the water and the minimum waste of water in the strata. The adoption of measures of this character, which are not compulsory at present, are precautions which it feels might reasonably be required compulsorily unless there are conclusive reasons to the contrary.

WASTE FROM OVERFLOWING BORE-HOLES.

The Sub-Committee has not investigated the question of compensation for damage to waterworks or water supplies which arises out of mining operations. This question is, it remarks, bound up with that of compensation for damage due to mining subsidence generally, and has been deferred, pending the report of the Royal Commission on Mining Subsidence. Its attention has, however, been drawn to the waste of underground water flowing from bore-holes, other than those used for public water undertakings. It is informed that in an area in Lincolnshire, comprising the Urban District of Bourne and neighbouring districts, there have been sunk into the same underground water-bearing formation more than 170 bore-holes, of which about 50 have been left unsealed, with the result that large quantities of underground water are allowed to run to waste. Public water undertakers derive their water from this underground formation and have experienced difficulty at times in obtaining sufficient supplies for public purposes consequent on the loss of water from the overflowing bore-holes. The Sub-Committee, therefore, considers that measures should be taken to prevent such unnecessary waste of underground water, and it recommends :—

(*a*) That a provision should be enacted making it unlawful for any person to cause or allow underground water to escape from any boring on his land, except and in so far as such water is required for his own use or for the use of some other person.

(*b*) That if any person contravenes this provision, he should be liable, on summary conviction, to a penalty not exceeding £10 and the Court should be empowered to make an order directing the boring to be effectively sealed or such other order as appears to the court to be requisite to prevent undue waste of water.

(*c*) That if the person on whom an order is made fails to comply with the same, the court should be empowered, on the application of the statutory water undertakers or the local authority, as the case may be, to authorise them to do whatever may be necessary in the execution of the order, and any expenses incurred by them should be made recoverable as a civil debt from the person on whom the order is made.

(*d*) That no proceedings for the enforcement of this provision should be taken except by the statutory water undertakers or by the local authority in whose area of supply, or in whose district, as the case may be, the boring is situated, and the consent of the Minister of Health should be required before such proceedings are taken.

CONTAMINATION OF UNDERGROUND WATER.

Under the heading of Contamination of Underground Water the Sub-Committee states that, whilst the common law may, in a few cases, afford some protection to the water in a well subject to pollution from a cause, which can be readily traced, it gives little or no security in the great majority of underground water supplies in connection with which it is difficult, if not impossible, to establish that the water supply is endangered, or the precise source of pollution, if pollution has been shown to have occurred. Whilst, it remarks, there can be no doubt that the operation of the provisions of the Public Health Acts and the by-laws of local authorities have reduced the amount of pollution, which would otherwise gain access to and contaminate underground water supplies, the express provisions of the general law for preventing the pollution of water supplies appear to be directed in the main towards the protection of surface water rather than underground water.

The Sub-Committee does not propose that any alteration should be made in the various sections of the Gasworks Clauses Act and the Public Health Act, which deal with the question, but it does recommend that Sec. 61 and 62 of the Waterworks Clauses Act, 1847, should be enlarged so as to render them more clearly applicable to underground water supplies, and for this purpose it makes suggestions for certain alterations which are set out in an Appendix to the report.

PROVISIONS IN WATER ACTS.

It further suggests that certain provisions which are now only contained in Acts referring definitely to certain undertakings should be made general. A list of some of these provisions is given in the report. The Sub-Committee further considers that the time has arrived when all statutory water undertakers should have conferred upon them the powers for protecting their water supplies from contamination, which Parliament ordinarily gives in individual cases when requested to do so. It also suggests a general provision making it unlawful for any person to cause or suffer the deposit of any solid in the subsoil, or the discharge of any liquid into the subsoil, in the vicinity of any well or adit so as to pollute or be likely to pollute any water in such well or adit used or likely to be used for domestic purposes. Such a provision might, it considers, be embodied in the Public Health Acts.

REGULATIONS BY THE MINISTER OF HEALTH IN SPECIAL CASES.

The Sub-Committee also recommends that the Minister of Health should have conferred on him a power to make regulations for preserving the purity of underground water and to declare the regulations to be in force in the area specified in the regulations, if he is satisfied that the purity of the underground water is endangered and that special measures are required for removing the danger. The regulations should direct by what authorities the regulations should be enforced and should make provision for compensation for any injury arising from their enforcement.

CONCLUSION.

Finally, the Sub-Committee states that, in the course of its deliberations, it has been impressed with the difficulty and inconvenience arising out of the fact that the general legislation relating to water supply is scattered over a large number of Acts of Parliament, some of which were enacted many years ago and require remodelling to meet existing conditions, and that it is in accord with the Water Power Resources Committee in recommending that the general statute law on this point should be amended and brought up to date and consolidated in one Act of Parliament at the earliest opportunity.

We may add that copies of the full report, which is signed by Messrs. A. R. Atkey, Alfred B. E. Blackburn, A. E. Cornewall-Walker, Fred. W. Macaulay, and William Terrey, may be obtained from H.M. Stationery Office, or through any bookseller, price 2d.

MOTION OF ELECTRICITY IN METALS.

PROFESSOR H. A. LORENTZ, of Haarlem, delivered the fifteenth annual May Lecture before the Institute of Metals in London on May 6th. After some introductory remarks regarding the constitution of atoms, the number of electrons contained in a metal, and their state of motion in the atom, the lecturer considered the mean velocity of the electrons when there was an electric current, and showed how Ohm's law could be understood without going into the details of the electronic motions. On the same general grounds, an explanation was given of Tolman and Stewart's experiments, by which it was experimentally proved that an electric current in a metal consisted in a motion of negative electrons and the dynamical theory of electromagnetism, as set forth in Maxwell's treatise, as applied to these experiments. The lecturer then proceeded to the discussion of Drude's theory of the conductivity for electricity, and for heat, and of some questions connected with it, insisting on the manner in which the number of free electrons was limited by the value of the specific heat. The remaining part of the lecture was devoted to the phenomenon of supra-conductivity discovered by Kamerlingh Onnes, and particularly to one of his later experiments, made with a suspended thin spherical shell of lead, in which a system of persisting parallel circular currents had been set up and which was placed in an external magnetic field the direction of which did not coincide with the axis of the current system. It was shown that in these circumstances, if the electrons were absolutely free, the axis of the current system ought to have a precessional motion about the line of force passing through the centre. No trace of such a precession had, however, been observed. The conclusion was that, even in a supra-conductive metal, the electrons are not wholly free in their motion. It seemed as if definite paths were prescribed them, along which they could move without encountering a resistance, but which they could not freely leave sideways.

A Method of Increasing Workshop Efficiency.

By FRANCIS J. SHARR.

AN attempt has recently been made to improve the industrial situation in a large engineering works by offering the men a number of "Conditions," known to be highly prized by them, in exchange for increased output. This offer was backed by an organisation, specially designed to remove all reasonable grounds for suspicion and to make attainment of its object possible. Two highly interesting and significant new features were developed in connection with the experiment—a standard of performance and security of employment—and the results have been so satisfactory as to warrant the hope that a brief description of the system may prove a useful contribution towards the solution of the general problem of industrial relationships.

The experiment was started in a manufacturing machine shop, divided into ten departments and employing 750 men working under a premium bonus system. The men are strong trade unionists, and, owing to *cliques* and their retention of membership in trade unions, the loyalty of the foremen was suspect. The aim of the experiment was the promotion of goodwill in the men; the basis of the method, the exhibition of goodwill by the management.

Three examples will perhaps serve to indicate broadly the nature of the "Conditions" offered:—

(1) In order that each man shall be placed in a position to determine for himself "How do I stand?" a standard of performance was established, which the management agreed to accept as satisfactory.

(2) The value of superior work is recognised, and is rewarded by giving to each man control over the security of his own employment.

(3) Fairness of trial, in cases of discipline, is ensured by defined procedure, and is exercised as a right, not as a favour.

An earnest attempt has thus been made to satisfy the aspirations of the better men, and to relieve their minds of a wearing anxiety as to the security of their job.

To put into operation the scheme outlined above, organisation is necessary, both in order to make the policy practicable and to establish confidence. This organisation has been designed primarily to provide reliable and unbiassed information upon the qualities and proficiency of the men, and to assure to those who merit it a substantial reward—necessarily other than money—proportional to their superior performance. In order to discover the good men, independently of possibly biassed foremen, routine weekly reports, covering certain points for all the men, are made. These weekly reports are posted to intermediate records, from which at quarterly intervals postings of the totals are made to individual summary records, where they are co-related for the purpose of making comparisons.

Before reliable comparisons were possible, however, a standard of performance had to be devised. The practicability of the whole scheme depended on satisfactorily constituting such a standard. Two main types were considered:—(1) An idealistic standard, by which a man's performance is measured negatively, *i.e.*, by the extent of his failure to reach an impossible goal. This is too depressing to be effective. (2) An attainable standard, by which a man's performance is measured positively, *i.e.*, by the amount by which he either surpasses or fails to reach the performance of a hypothetical *average* man. In this type, the good man enjoys the satisfaction of accomplishment, whilst the bad man is spurred on to further effort in order to show that he is at least equal to the average. Since even the best men have their bad points, which tend to lower their value, the standard must necessarily, if it is truly to represent a man, be composite, comprising factors both for and against him. These factors are regarded as credits and debits respectively. Both these, again, are composite, and great care was necessary in selecting their components, in order that no element of unfairness should creep in. Hence, only such factors are employed as apply equally to all men, and such as each man has under his own personal control, for which, therefore, he will recognise his direct responsibility.

Only five factors were found to comply with these conditions:—Two credits: Work done and length of service; and three debits: Bad time-keeping, debts, and scrap. Each of these factors is evaluated to a recognised scale, which, though admittedly arbitrary, nevertheless preserves a sense of relative values.

The basis of this scale is the performance of an average man without faults. An "average" man in this connection is a hypothetical person, whose performance is exactly equal to that of the average for the whole shop or department. This is the recognised standard of performance. Better men show higher, and worse men lower than it. But since conditions vary considerably as between one department and another, it became necessary to determine a separate average for each. Conditions also vary from time to time, and each average is therefore redetermined quarterly, in order to ensure that the standards shall be always up to date. Totals for each of the five factors mentioned are posted quarterly to summary records, one being provided for each man, and the balance, after deducting debits from credits, is entered up. This balance is known as the index figure. This index figure is the feature which renders comparison possible, whether it be between a man's present and past performances, or between one man and another. It has proved in practice a remarkably reliable index of relative performance. Every case of apparent discrepancy between the index figure and a man's known merit has served to reveal a defect in administration. Rectifications thus facilitated have been to the advantage of everyone. It is no small tribute to the index figure, as thus determined, that it has never been queried, even by the men concerned, since it was instituted. The records are kept on loose leaves and are filed in order of merit, thus showing visually the relative value of every man in a department. By placing the lowest index figures to the front, the worst men are brought most prominently under notice, and action is facilitated. There are two such files—"live" for men still employed, and "dead" for men who have left. An example of a typical form of record sheet is given below.

It will be observed that every factor employed is known to each man. He is therefore in a position to determine for himself his standing and to check the accuracy of his record. The utmost care is taken to ensure the arithmetical accuracy of the records, and every mistake found is corrected immediately. The record is regarded as the joint property of the man and the company. The company keeps it for the sake of convenience, but the man is given all reasonable facilities to consult it, and advice thereon is willingly given. Especially in cases of discipline is the record openly "in evidence," in order to impress on the man the genuineness of the desire not to take the slightest advantage of him, but, rather, to give him the very utmost of credit. The effect of this simple provision in promoting confidence has been remarkable.

No.....Name.....

Rate Section

Date.	M or S	Time Lost.	%	Debts.	%	Scrap. £ s. d.	Bonus. Man's Av.	Bonus. Shop Av.	+ or −	Service, Total Years.	Index Figure.

Security was offered, as the most valuable appreciation of good work, well done, that the company could bestow. Since each man recognises his responsibility for each of the factors on which his index figure is based, he cannot escape responsibility for the index figure itself, and consequently for the position of his record on the file. When discharges became necessary for causes other than individual misconduct, the propriety of retaining the best men is manifest. It is a preference due to such men, earned by them by superior effort. It is also manifestly in the company's interest. This identity of interest is emphasised. The least useful men, therefore, are the first to go. Under the filing system adopted these are the men whose records are reached first, through having the lowest index figures. It will now be evident that a man can, by hard work and avoiding losses, obtain such a high index figure as will place his own record out of reach of "the firing line." Thus he may procure his own security of employment. Security is, in fact, dependent upon and proportional to performance, augmented by "goodwill" created by continuous service. The ultimate monetary value of these provisions, even though it be indirect, is quite evident to the men.

When a man leaves, his record is removed from the "live" file. It is brought right up to date, the cause of leaving being noted thereon and placed on the "dead" file, with order of merit reversed, *i.e.*, the highest to the front, and each department by itself. Then, when more men are required, it is manifestly best to bring the most useful men back first, *i.e.*, the men whose index figures are highest, whose records, in fact, are reached first. Again, identity of interests is emphasised. The best men out reap a reward for their previous good service by being given the earliest opportunity of increasing their incomes by re-employment. The monetary value of this, though naturally less than before, is, however, fully appreciated. The worst men, on the other hand, allow so many better men to get a higher index figure—thus establishing a prior claim—that they ruin their own chances of re-employment. The seriousness of this result causes even the hottest heads to pause. Thus, too, the company is protected against the continued employment of men manifestly unsuitable, no matter how strong cliques may be. There are thus two sides to this procedure. On the one hand, the best men may earn complete security and uninterrupted income by superior work, whilst less good men may at least retard their discharge and advance their re-engagement, so reducing their loss. These conditions are clearly to the men's advantage. On the other hand, proved "inefficients" are permanently excluded, which is to the company's advantage. By continually emphasising and illustrating in this practical way this identity of interest, the falsity of certain prevailing theories is effectively exposed and the direct advantages of co-operation is impressed upon the men. In effect, the greatest force in Nature, self-preservation, has been once more re-directed into the beneficial course of increasing output instead of being wasted in restricting output. The significance of this needs no stressing. It is the key to the ca-canny problem.

The interest of both master and man in maintaining security being one, although based on differing motives, it is of paramount importance that this security be not menaced by anything, even accident. The importance of this provision is so seriously regarded that the right to discharge men has been withdrawn from the foreman and transferred to a fully responsible member of the staff, possessing both technical and psychological qualifications. He only acts after full investigation. Experience has proved that this arrangement in no way diminishes a foreman's authority. On receipt of a foreman's requisition the man's record is made up to include the most recent data available, in order that nothing in his favour shall be lost sight of. The complaint is then examined in the light of this evidence. If corroborated, the man is then, and then only, notified of his discharge and of his right to appeal. So careful, however, is this examination that appeals are extremely rare. When corroboration is not evident, and in every case of misconduct an investigation is made, *in camera*, if that appears to be desirable in the man's interest, and only in the gravest cases does dismissal take place. The whole aim is reformation rather than elimination, and by its means scores of men have been changed into thoroughly loyal and satisfactory workers. In a word, they have been satisfied.

A few illustrations showing how, by safeguarding the men's interests, the good will aimed at has been won may not be without value. A man was requisitioned for discharge as "too slow." Examination of his record, however, showed him to be consistently some 15 to 20 per cent. above the average. This conflict of reports suggested an error somewhere, and investigation proved that the foreman had been completely misled by the slow but efficient movements of the man. When he realised his error the foreman became as anxious to retain the man as previously he had been to have him discharged. An exceptionally efficient man was thus protected against an error of judgment and an injustice he would have found it very hard to oppose; the company was protected against the loss of a valuable man; and the foreman gained some valuable experience. Another illustration of identity of interests.

Another man scrapped a whole batch of work valued at £80. He, of course, expected immediate discharge. Investigation revealed a misunderstanding with the sample viewer. The record was examined. It was unusually good; no scrap at all for five years. Obviously the man was not careless; his version of the mishap received, therefore, indirect support from his record. He was sent back to his job. Such evidence of good service for five years was not to be ignored, even in face of such a serious loss. The interests of the man demanded that it should be considered. The company's interests, too, required it, for a discharge would have involved the loss of the capital represented by the man's accumulated experience in the shop. Once more it was both parties that gained.

Another man had a consistently poor record. The wisdom of retaining his services was discussed with his foreman, who was dismayed and protested emphatically that he was about his best man, the one to whom he gave most of his "specials" and "bad" jobs. He neither made scrap nor complaints. Investigation showed the man to be a really good man, but of an unassertive type, who had been taken advantage of by the rate fixers. This matter was adjusted to the man's surprise and pleasure, and the foreman learned the importance of securing justice for his men. It was a manifest injustice that a man who, because of his very excellence, had the trouble of all the most worrying jobs in the shop, should in addition have the trouble of an incessant struggle with the rate fixers, only to find himself at the finish with only about one-third of his rightly earned premium and with his security of employment menaced. It is perhaps unnecessary to stress the moral effect of such incidents as these on the other men.

A different class of illustration will serve to indicate the importance of the indirect reactions of this system on other departments outside the machine shops and their value as indications to the management of the

presence of inefficiency therein. A man, anxious about his security and at the same time losing bonus, complained about defective tool service. Investigation revealed widespread inefficiency in this connection, affecting many men. Suitable administrative action was taken, by which the loss of many hundreds of not only wage hours, but production hours also, weekly was disclosed to the management, which took appropriate action, not, however, with respect to the tool-room alone, but also to every other service department. Similarly, the effect on production of an alteration in the size of batches of work by the planning department was very quickly and clearly disclosed.

Under this new incentive men are no longer content to lie down under preventable inefficiency. A new and keen interest in the promotion of efficiency all round has in fact been created in the men, exerting a subtle but powerful influence right outside the shops in which the system is nominally operating. The outcome of this, in conjunction with the will to work also created, has been the attainment of the following results. In considering them the strongly marked trade union character of the shops, already mentioned, should not be overlooked. When it is taken into account the significance is considerably enhanced.

Average Figures for a Period of One Month.

	At start of experiment.	Two years later.	
Wages, per week	£3433 9s. 8d.	£1561 7s.	Redn. = 54½%
Output, finished parts per week	43,750	57,570	Incr. = 31½%
Output, per man per week	69.7	106.5	Incr. = 53%
Scrap, total value per week	£194	£73	Redn. = 62½%

The substantial character of these results is regarded as fully justifying the assumption upon which the whole experiment was based: that the crux of the problem of industrial unrest is primarily spiritual, and that if it be approached sympathetically from that side the interests of both masters and men will be most effectively promoted. Everything possible has been done to remove all grounds for suspicion. But the spirit dominating this effort has gone far beyond that by going out to meet the men and offering them the maximum possible assistance in their efforts to satisfy these, their higher, aspirations. It is indeed a pleasure to be able to testify to the whole-heartedness of the response of the men to these overtures. This is only one of several such experiments, and in view of similar and even more striking results obtained under various conditions, it is felt that similar methods, actuated by the same spirit, would, if generally adopted, bring back to industry a substantial share of that good feeling, and with it of that prosperity, of which it stands in such sore need to-day.

Steep Ropeways in South Wales.

In the course of a recent visit to South Wales we had occasion to call at several of the local collieries and were struck by the extent to which wire ropeways have been adopted there within recent years for transporting the refuse brought out of the mines. It is, of course, the practice in that coalfield to sort the shale and rubbish from the coal in the workings and to send it out in separate trams, as it is not found economical to stow the dirt in the workings. This shale has consequently to be dumped on the surface, but the local topography is such that it is not easy to find dumping ground. Most of the pits are near the bottoms of valleys and the ground rises steeply on both sides. As a consequence the mountain tops are about the only places where the dirt can be dumped, and it has to be hauled up very steep slopes to get it there.

A ropeway is obviously an excellent means for doing such work, but the conditions are far more arduous than those met with generally, a fact which will be appreciated from the engravings which we reproduce in our Supplement and on page 518, and from the following notes referring to three ropeways put up for the purpose by R. White and Sons, of Widnes.

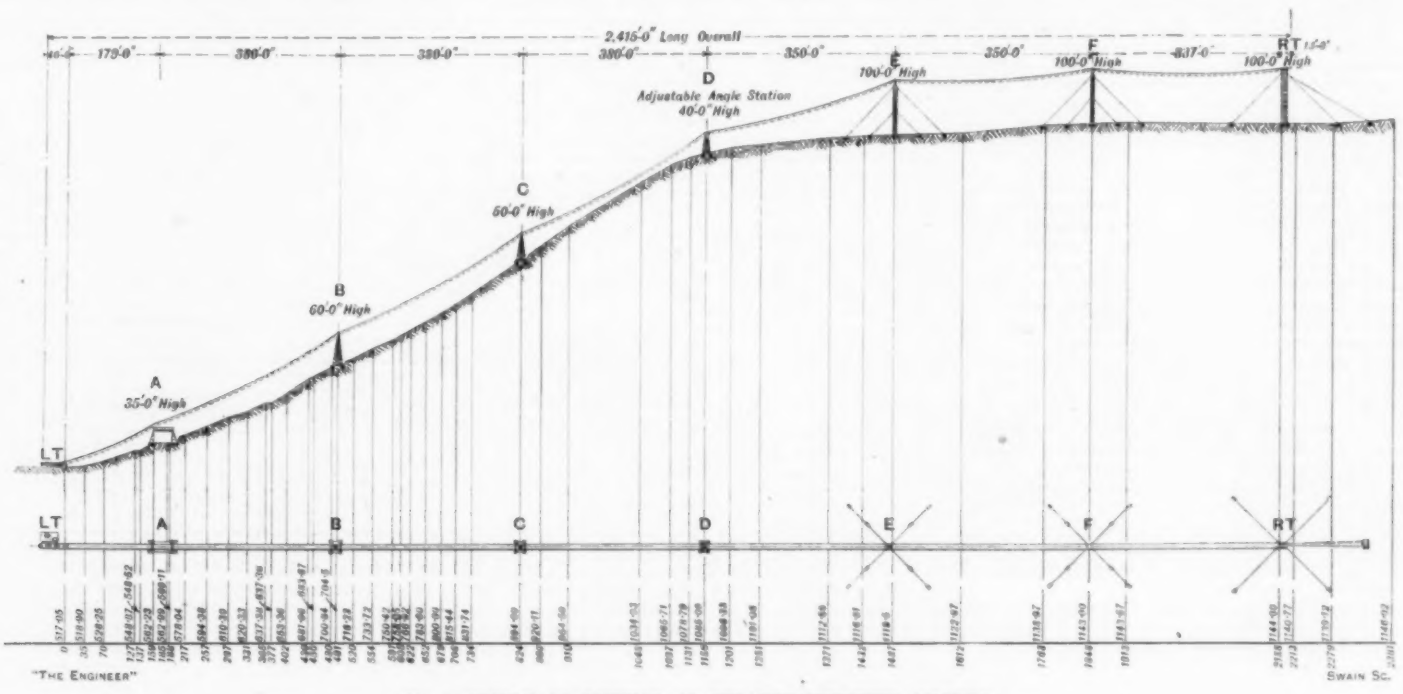


FIG. 1—PROFILE OF ROPEWAY AT THE PENLLWYNGWENT COLLIERY

Plant at Penllwyngwent Colliery.

Of these three ropeways it is rather difficult to say which is the most interesting, as the difficulties which have had to be overcome are different in each case; but that shown in the line drawing Fig. 1 and some of the engravings of the Supplement is noteworthy on account of its steepness—it is, in fact, said to be the steepest of its kind in the country. It is at the Penllwyngwent Colliery of Cory Brothers and Co., Ltd., in Ogmore Vale, South Wales.

The total length of this ropeway is 2415ft. and it has a capacity of 30 tons per hour in 10-cwt. loads dispatched at the rate of one every minute, so that with a rope speed of 200ft. per minute the loads are spaced 200ft. apart along the line. As will be seen from the profile Fig. 1, in which the levels given refer to the surface of the ground, the total rise of the ropeway is over 700ft., but the greater part of this rise is concentrated in the first part of the line, as the top of the mountain, where the dumping takes place, is comparatively flat. The first 150ft. or so present the steepest part of the line, as it has to be brought up abruptly enough to clear a public roadway. The slope of the cable at this part is plainly shown in two of our engravings. The mean gradient between the loading terminal, and the first tower, as shown in the drawing, is roughly 1 in 2½, but the loading terminal has, since the plant was erected, been lowered into a pit below the ground level, so that the steepest gradient is now 1 in 1.4, while the average gradient against the load throughout the line is 1 in 3½. It will be readily appreciated that a very powerful grip on the hauling rope is necessary to haul the loads up such slopes as those just mentioned, and that part of the equipment is described later.

Up to the tower marked D the structures are all permanently fixed, and the alignment of the ropeway is straight in plan, but from that point onwards it is possible to deflect the line sideways so that the area of the dump may be developed fanwise and a corresponding increased tipping capacity obtained. Up to the present, however, the plain straight route has, as will be seen from the engravings, provided ample area. It will be seen that the towers of the dumping section of the line are all 100ft. high, which gives accommodation for at least half a million tons of *débris* before the alignment of the ropeway need be altered.

The carrying rope is of the locked coil type of 1½in. in diameter and has a tensile breaking strength of 90–100 tons. It is tightened up in place under a tension of approximately 12 tons, and is supported

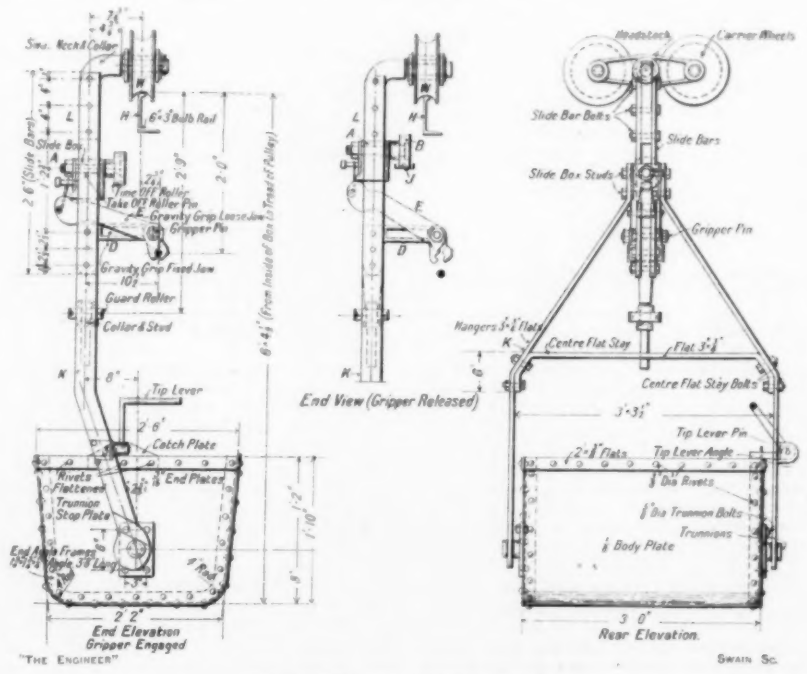


FIG. 2—SKIP AND GRIPPING DEVICE

at the towers by extra deep saddles, so that the carrier wheels do not ride on the rope itself as they pass the towers and the rope is consequently relieved of the wearing action of the wheels where it is most heavily stressed. The hauling rope is of the flattened strand type ⅞in. in diameter and of 25 tons breaking stress. The tension in this rope is kept at 1½ tons by means of a counterweight at the loading station.

At the loading station, of which we give an illustration on page 518, the skips are filled with shale from a hopper, during which process the carrier wheels run on a fixed rail carried by steel framing. When full, the skips are pushed a yard or so along the rail by the

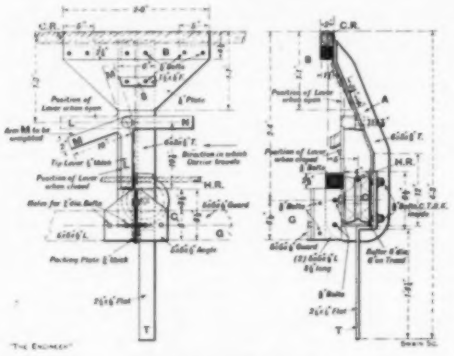


FIG. 3—TIPPING GEAR

man in attendance, and a gripper on the trolley automatically takes hold of the hauling rope. At the dumping area a tipping gear fixed to the carrying rope catches a trigger on the skip and upsets it. The empty skip is carried by the rope round the return terminal and down the slope to the loading terminal, where it is automatically disconnected from the hauling rope and run to the hopper by hand. It will thus be seen that after the skip has left the bottom with its load it requires no attention until it returns empty. It does, in fact, go out of sight over the brow of the mountain, and on the occasion of our visit the engineer in charge said that no one had been up to the top for a day or so, as it was obvious that if the skips went up full and came back empty everything was going on all right, while the running sheaves required very little attention for lubrication.

The gripping device for locking the carrier to the hauling rope is the subject of one of Messrs. White's latest patents. It is of the gravity type; that is to say, the gripping force is provided by the load itself. The hanger which carries the skip has a sliding joint near the top and is provided with two sets of running wheels. The top wheels W W, Fig. 2, are those of the trolley proper and run on the carrying rope or the rail H in the loading terminal. The smaller wheel B actuates the grip in the following manner. Normally the weight of the skip is carried by the stirrup K and slide box A resting on the end of the lever E. This lever is in one piece with one jaw of the gripper, while the other jaw is fixed to the bracket D, which is bolted to the hanger L. It will be seen that the whole load is consequently utilised in gripping the rope. When

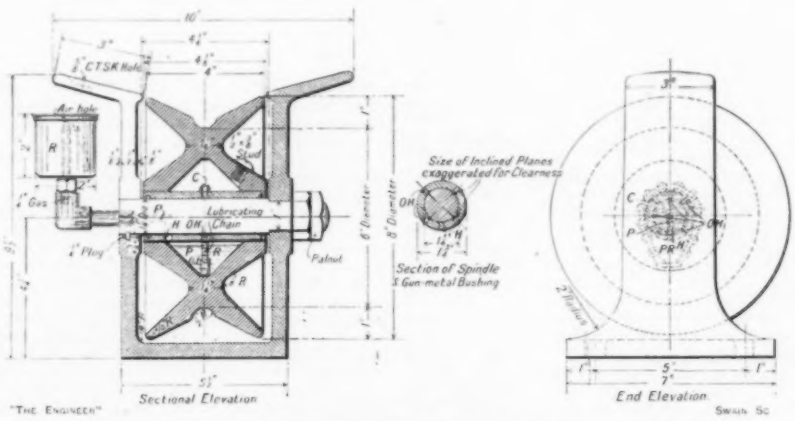


FIG. 4—SELF-LUBRICATING GUIDE ROLLER

the empty skip runs into the loading station the trolley goes on to a rail which has a slight dip in it, while the small wheel B is picked up by a more or less horizontal rail J below. The result is that the weight of the skip is transferred to the small wheel and the weight of the trolley causes the two parts of the hanger to slide on one another, so that the gripping jaws are opened and the rope is released, as shown in Fig. 2. After being loaded the skip is pushed on to a place where the lower rail slopes downward faster than the running rail, and the weight is consequently returned to the running wheels through the two jaws of the clip.

It will be noticed that the clip has a very powerful leverage and the grip on the hauling rope is very tight, so that there is very little likelihood of it slipping. There are, however, occasions when there is an added tendency for the rope to be torn out of the clip, such, for instance, as when the skip is passing a tower at the bottom of a hollow or when an empty skip is coming down and there is no load available for increasing the grip. For this reason the heel of the moving jaw of the grip is arranged to jam against an abutment, as shown in the drawing, when the grip is closed, and can only be opened by the positive action of the locking rail.

The loading station at Penllwyngwent is, as already mentioned, arranged in an excavation, and mounted above it there are two electrically operated tipplers. The tubs of shale are run into these tipplers and their contents dumped into a 200-ton hopper, from which the ropeway skips are loaded below. The empty tubs are returned to the mine by gravity.

The terminal comprises a heavy steel framework,

FIG. 5—BRIDGE TO PROTECT ROADWAY—PENLLWYNGWENT COLLIERY

to which the carrying ropes are anchored by means of long tension bolts, and the gearing for driving the hauling rope. The hauling rope makes two and a-half turns round the "fleeting" or driving wheel and a half turn round a tension pulley, which is mounted in a carriage weighted to maintain a constant tension in the rope. The driving wheel is revolved by a 50 horse-power electric motor through totally enclosed chain reduction gear, running in an oil bath, and a set of bevel gears. The whole of the transmission is arranged on the top of the terminal framing, so as not to interfere with the floor space.

In order to prevent the skips running back down the slope, if the ropeway is stopped when loaded, a ratchet wheel, with two pawls, is keyed on the fleeting wheel shaft, and a brake band operated by hand screw gear is provided. A set of light gears connected with the driving gear operates a gong at one-minute intervals to notify the attendant when to dispatch the loaded skips.

Originally the carrier wheels of the skips, together with those for supporting the hauling rope at the towers, were all fitted with ball bearings; but it is noteworthy that for some of the renewals which have been required on account of ordinary wear and tear, a special form of self-lubricating gun-metal bearing, devised by Messrs. White, has been adopted. In these bearings, the place of ordinary oil grooves is taken by wide sloping faces, or inclined planes cut axially along the bearing face. The oil is fed in between these sloping faces and the journal, and is dragged in between the bearing parts of the bushing somewhat on the same principle as in the Michel thrust bearing. The details of one of these bearings for a hauling rope roller are given in Fig. 4, which shows the wick feed oil reservoir at R. The oil is led into the axial hole P in the fixed spindle, and escapes by the port H in the bushing. As this port registers with the end of the hole P only once in every revolution, the rate of feed is reduced to a very small amount. The oil collects in the reservoir P R in the roller, and is picked up by the chain C, from which it finds its way into the bore of the bushing by four holes O H. It is then dragged up the inclined planes, as already explained, to lubricate the bearing surfaces. The reservoir holds sufficient oil for several weeks' service, so that it is necessary only occasionally to replenish the supply.

The gear by means of which the loaded skips are tipped at the dumping ground is illustrated by the line drawing, Fig. 3, and can be seen in action in several of the photographic engravings. It is attached to the carrying rope and can readily be moved from place to place as tipping proceeds.

The tipping gear, it will be seen, consists of a T frame A with a bent plate sleeve B, which is made for fixing directly to the carrying rope C R at any required point along the ropeway. A hauling rope roller C, fitted with ball bearings, is provided to support the hauling rope and keep it in a fixed position at all times at the tipping gear. A lever with two arms L and M is pivoted to the frame, and rests in ordinary working in the position shown in full lines on the drawing, so that the vertical arm L effectually prevents the hauling rope from coming off the rope-supporting roller C.

Assume that a carrier box is approaching the tipping gear in the direction shown by an arrow. When the hauling rope gripper on this carrier comes up to the tip lever arm L, the hauling rope is, of course, lifted up above the roller C, being carried in between the gripper jaws which have to pass over the hauling rope roller without fouling. The nose of the hauling rope gripper will then push the tipping lever arm L out of position when passing through the tipping gear, and the tipping lever will momentarily assume the position indicated by dotted lines on the drawing. Whilst in this position the rear tail N of the lever will assume a vertical position, so as to prevent the hauling rope coming off the roller when a carrier passes through. As soon as the rope gripper gets beyond the end of the lever part L, the lever will fall back to the vertical position again, and maintain the guard over the rope.

As a loaded carrier and box pass through this tipping gear, the tipping lever provided at the top of the carrier box—see Fig. 2—engages with the trigger bar T—Fig. 3—which knocks the tip lever on the bucket out of gear, and the loaded bucket tips automatically in the ordinary manner.

This tipping gear has now been used for a good many years, and has been found effective, and safe under all working conditions and in all kinds of weather, even in very exposed positions on the top of mountains or the like. It will be observed that no guy ropes are required to hold the tipping gear in position by anchoring it to the ground, which is rather an important point, as it saves a lot of trouble in fixing. Furthermore, the gear is light and portable, so that it can easily be moved from point to point by sliding or pulling it along the carrying rope.

An oil box, which is used to lubricate the carrying rope as the skip travels round, is fixed above the trolley on one of the carriers. It has an adjustable drip feed and a brush trailing behind the nozzle, which spreads the oil evenly over the rope. For

lubricating the hauling rope an oil box with drip feed is fitted up on the loading station framing in the ordinary manner.

Plant at Wyndham Colliery.

The Wyndham Colliery, also belonging to Messrs. Cory, is on the opposite side of Ogmore Vale to Penllwyngwent, and is equipped with a White's ropeway, of which we give several illustrations. It is of the same capacity as that just described, and is constructed on the same general lines; but it is not quite so steep. The average gradient is about 1 in 7, while the steepest slope against the load is 1 in 2¼. It is, however, considerably longer, being 3188ft. long, and commands a much greater dumping area, as there are four towers 100ft. high and one 90ft. high, on the mountain top, along a length of some 1300ft., and the whole of this section can be arranged to spread out fanways. This dumping ground is well illustrated by a picture in our Supplement, which shows also the exposed, wind-swept nature of the land. The ropeway was, nevertheless, kept in operation throughout the severe wind storms of last winter without any mishap. Up to the present, it has only been necessary to tip at one spot along the line, although the ropeway has been working for two years, a fact which gives some indication of the vast amount of waste which it will be possible to dispose of by means of this installation. The hopper at the

FIG. 6—RETURN TERMINAL AT BWLLFA DARE COLLIERY

loading station is very similar to that at Penllwyngwent, but arrangements have been made so that it can be extended to 400 tons capacity by lengthening the station. About 35 horse-power is required to drive this ropeway when fully loaded.

Plant at Bwllfa Dare Colliery.

The third ropeway mentioned at the beginning of this article is at the Bwllfa Dare Colliery, near Aberdare, of the Bwllfa and Merthyr Dare Steam Collieries (1891), Ltd., and was also supplied by R. White and Sons. It is chiefly noteworthy because it was able to continue working in very adverse conditions. Its total length is 1470ft., and it has a capacity of 50 tons an hour in 12½ cwt. loads, at the rate of eighty loads an hour, so that with a hauling rope speed of 210ft. a minute, the carriers are spaced 157ft. apart along the line.

In this case the spoil, which is a mixture of pit and washery dirt, is dumped all up the slope of the mountain on an average gradient of about 1 in 4, but there are some steep places where the gradient against the load is from 1 in 1½ to 1 in 2, and it will be readily appreciated that tipping the load on such a slope is a severe test of the ropeway.

The chief difficulty with this line has, however, been caused by the land sliding. The ropeway has now been in service about nine years, and the heap of dirt which has accumulated in the interval amounts to roughly a million tons. Its extent may be gauged by a comparison of the photographs, reproduced in our Supplement, taken when the ropeway was first erected and again within the last few weeks. This added weight has caused the whole mountain side to slide. The seriousness of this landslide, which is continuously going on, is well shown in one of our engravings. It will be seen that a great mass of the dump has slipped out sideways, and has carried with it two of the cableway towers, which were originally some 75ft. high. An attempt was made to keep one of these towers in place by anchoring it back to some growing oak trees on the mountain side by wire ropes, but the trees were uprooted and the tower had to be abandoned, so that the cableway is now working minus two of its towers—a fact which may be observed by a comparison of the illustrations.

The dump, it will be seen, has accumulated to such an extent that the skips are in places rubbing along the top of the heap, and some "dummy" towers have been erected on the top of the spoil to increase the dumping accommodation. The slipping has carried the remaining towers out of their original alignment, so that, in spite of additions and alterations to these structures the ropes are not nearly in line. In such circumstances, the hauling rope, naturally, cannot lead properly with the carrying rope, but the ropeway continues to do its work quite satisfactorily. It has, of course, been necessary to bind the carrying rope down to the saddles at the towers, which are out of line, and to arrange special rollers to support the hauling rope, but otherwise no special precautions have been taken to help the skips round the angles.

The loading terminal of this ropeway is 60ft. long by 9ft. wide, and has a hopper of 200 tons capacity. There are two power-driven tipplers for discharging the loaded pit tubs into the hopper, and shoots fitted with White's semi-circular valves for loading the dirt into the skip. The electric motor, which is of 50 horse-power, is arranged in a house alongside the terminal and drives the fleeting wheel through an underground shaft. The first speed reduction is effected by a belt running on fast and loose pulleys. There is then a set of spur gears and finally bevel gearing on to the driving wheel shaft. The vertical shaft also has a ratchet wheel to prevent the ropeway running backwards, if it is stopped with a full load going uphill. The tipping gear and all the rest of the equipment are very similar to that already described.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE MECHANICAL EQUIVALENT OF HEAT.

Sir,—Engineers and scientific men throughout the country are profoundly indebted to Professor Haldane Gee for his presentation for the first time of details of the great Joule's earlier experiments in his quest for the mechanical equivalent.

In these days of splendidly equipped laboratories workers can but dimly visualise the almost appalling difficulties and disabilities under which early investigators laboured.

At the very outset Joule was faced with the fact that reliable thermometers were unobtainable. Their chief defect was the intermittent and jerky rise and fall of the mercury in the stem of the thermometer. In his article on "Heat" in the *Encyclopædia Britannica*, Ninth Edition, Lord Kelvin wrote:—

> "Dr. Joule informs us that this defect is much greater in some thermometers than in others, and that he believes it is greatly owing to the tube being left unsealed for too long a time after the introduction of the mercury—by which it is to be presumed something of a film of oxide of mercury is left on the glass to reappear on the surface of the mercury when it sinks as it cools after the sealing of the end. In Joule's own thermometers not the smallest indication has ever been detected of what he calls 'This Untoward Phenomenon' which is calculated to drive an observer mad if he discovers it towards the close of a series of careful experiments. Their admirable quality in this respect is no doubt due to the great care taken by the maker, Mr. Dancer, under Joule's own instructions, to have the mercury and the interior of the bulb and tube thoroughly clean, and to guard it from exposure to any 'matter in its wrong place' until completion of the sealing."

Professor Schuster's subsequent investigation clearly demonstrated the extreme accuracy of Joule's thermometers.

In a previous contribution Professor Haldane Gee remarked upon the association of Mr. Dancer with Dr. Joule. Mr. Dancer died in 1887, predeceasing Dr. Joule by about two years, but for the last ten years of his life he was almost totally blind. In 1882, however, he dictated to his grand-daughter, then a tiny girl of ten, a brief account of his life and the more important of his official and scientific work. The following extract therefrom refers to his association with Dr. Joule:—

> "In 1843 Mr. Dancer assisted Dr. J. P. Joule in the production of accurate thermometers. The following account is copied from a sketch of the life of Dr. J. P. Joule, which is published in the *Biograph and Review* for November, 1881, published by E. W. Allen, London, page 451. At this time he—Dr. Joule—felt an increasing necessity for the employment of accurate thermometers, and he determined, with the assistance of the eminent optician, Mr. Dancer, to manufacture some for his own use. For this purpose he attended Mr. Dancer's works every morning for some weeks, until a few thermometers, the first which were made in England with any pretensions to accuracy, were completed. Of these, some were forwarded to Professor Graham and Dr. Lyon Playfair. Mr. Dancer arranged the apparatus for measuring the internal capacity of the bore of the thermometer tubes, and constructed the small dividing engine, which he used in graduating the scale on the thermometer tubes. He also made for Dr. Joule the apparatus which he employed in the determination of the mechanical equivalent of heat, his new tangent galvanometer, and many other novel instruments, also an improved form of apparatus which Dr. Joule used in his final experiments on the determination of the 'Mechanical Equivalent of Heat,' as given by Dr. Joule in the 'Philosopfical Transactions' for 1878."

It is an amazing and almost incredible circumstance that scientific men in those days—the early forties—neither understood nor appreciated the true significance of Joule's work. In the copy of the *Biograph* above mentioned which Dr. Joule handed to Mr. Dancer, we find the following:—

> "At the meeting of the British Association in 1847 at Oxford, Dr. Joule brought a paper on the 'Mechanical Equivalent of Heat' under the notice of the Physical Section. It was suggested that he should occupy as little of the time of the section as possible on account of the number of papers on the list. Under these somewhat discouraging circumstances, it was no small gratification to him when he saw a young man rise in the section, who by forcible arguments convincing the learned men of the importance of the experiments he had brought forward, led to an interesting and animated discussion. That young man was William Thomson, whose friendship Dr. Joule then formed and maintained for so many years."

Joule's work can be categorised as a revelation of absolute as distinct from relative vision, the differentiation that characterises the universal from the ordinary genius.

In Clerk Maxwell, Joule and Kelvin, we have surely the triumvirate of the physical science giants of the Victorian age, an age that produced a constellation of luminaries, such as John Dalton, Stokes, Lord Rayleigh, Tait, Osborne Reynolds, Baltour Stewart, Brewster, Lyon Playfair, Tyndall, Schuster, &c. &c. It should never be forgotten that the bearers of those names were no less conspicuous for their superlative modesty than for their scientific attainments.

To-day we have a galaxy of stars of all magnitudes in the physical science firmament, whose activities range from the ultimate constitution of matter to spatial limits. Will the product of any three of them in its beneficent and utilitarian value to the applied sciences and the industrial arts compare with that of the men mentioned above? Time will show, but in any case it is a source of no small satisfaction to know that the Manchester school endeavours to maintain the traditions of a worthy and illustrious past.

John Wilkie.

Worcester, May 6th.

CO_2 RECORDERS.

Sir,—The first CO_2 recorder I used was about twenty years ago on the Continent, the Ader. Since then I have used many other foreign-made recorders, and latterly have used English-made recorders at home.

If I were asked candidly to say how much saving I had effected during twenty years by means of the CO_2 recorder, my answer would be that I do not remember a definite case where saving was effected by the use of the above-mentioned instrument. Why is it that of all the recorders sold, a great many are standing unused, and as many confer no benefits? The answer generally given is that the engineer has not sufficient time to look after it, or is not competent to find out the defects of a boiler, and the various combinations of load, draught and superfluous air, &c. I know very well from experience that if I have an extra strong draught or leave an opening in front of the furnace I shall burn more fuel, which means that extra air admitted to the furnace is detrimental to economy: that is what a CO_2 recorder or analysis of the escaping gases determines. Surely if an engineer was sure he could save even 3 per cent. by using a recorder, he would stick to it and use it; but I know of many engineers who have used them and derived no benefits from their use.

Scientifically we know that to burn a pound of fuel theoretically x air is required, and to burn it practically $x +$ so much per cent. is required, and anything above that is superfluous air, which requires heating at the expense of the fuel. We also know that when a pound of fuel is economically consumed, the escaping gases should contain x per cent. of carbon dioxide, which is determined by analysis or the CO_2 recorder; therefore it is all plain and scientifically correct. But there is something wrong somewhere, and my opinion is that there is an unknown factor which comes into the combination.

If a CO_2 recorder on an average could save 5 per cent. of fuel, it would be a national saving, and there is no reason why such a saving could not be enforced; but it cannot be done. I am writing practically as I have found things, and it is for scientists to explain the paradox.

May 5th. A. Dott.

THE MOST POWERFUL BRITISH LOCOMOTIVE.

Sir,—In view of the general interest taken in the recent exchange tests of two very interesting locomotives, I should like to make a few remarks on the above subject.

There appears to be a good deal of misunderstanding with regard to what constitutes power, when referring to locomotive performance. If by "most powerful" is meant the engine which can pull the heaviest load, or, in other words, can exert the greatest tractive effort at the actual moment of starting, then the most powerful in England to-day is undoubtedly Sir Henry Fowler's four-cylinder 0–10–0 banking locomotive on the London, Midland and Scottish Railway, which, under favourable conditions, can give the enormous tractive effort of 43,000 lb. on the draw-bar. This powerful engine will, however, soon be eclipsed by the gigantic "Garrat" locomotive now being completed for the London and North-Eastern Railway, which will have a draw-bar pull greatly in excess of "the Lickey banker."

If, on the other hand, the term "most powerful" is meant to apply to the engine which can give the greatest power output, or, in other words, can perform the greatest amount of work in a given time, then the most powerful locomotive in England to-day is Mr. H. N. Gresley's famous 4–6–2 "Pacific" express engine. This engine, with its vast boiler and three high-pressure cylinders, can make and use a greater amount of steam in a given time than any other locomotive at present working in this country, and is therefore fully entitled to be classed as "the most powerful" in England to-day. How long this will remain so is a matter for speculation, for there are rumours of an even more powerful express engine making its appearance shortly.

Chas. W. Dauncey.

Birmingham, May 6th.

COAL-BURNING LOCOMOTIVES.

Sir,—In my account of early coal burning in locomotives in The Engineer of May 1st, I omitted to add that the fire-hole deflector plate was also independently introduced by G. K. Douglas, of the Birkenhead, Lancashire and Cheshire Junction Railway early in 1858.

E. L. Ahrons.

Nottingham, May 4th.

Railway Matters.

A VERY interesting fact was recently related by Mr. Whitelaw, the chairman of the London and North-Eastern Railway. He said that a somewhat curious result of the great development of motor traffic was that whilst cattle were now frequently conveyed in motor vans, sheep were coming to the railway on account of the great difficulty and danger of driving them along the roads crowded as they were with motor vehicles.

IT is very gratifying to hear that an agreement has been arrived at between the railway companies and the traders' co-ordinating committee as to the amount of capital the railway companies may claim as the basis upon which the standard revenue, under the Railways Act, is to be arrived at. An intimation as to this agreement was conveyed to the Railway Rates Tribunal the other day, and Mr. W. B. Clode, the chairman, said that, generally, the Tribunal sanctioned the agreement. He congratulated the parties on the achievement.

A LETTER in *The Times* on the need of an indicator at the Victoria Station, Chatham section, Southern Railway, to intimate the platform at which a train will arrive, has led to an announcement by the company which suggests that something wonderful in the way of indicators is contemplated. It is said that the new system will, if it proves to be all that is expected, be a big advance on existing types, and will include all information as to late or early running and as to duplicate and triplicate sections. Moreover, all the termini in the London area, including Waterloo, are to have similar indicators.

THE directors of the London, Midland and Scottish Railway announce that in view of the experience of amalgamation they have been considering the organisation of the executive control of the company, and that they have decided to create the post of President of the Executive. Sir Josiah Stamp has accepted their invitation to take this position, and the Board of Nobel Industries, Ltd., has agreed to free him from his administrative duties at the end of 1925. Sir Josiah Stamp will remain on the Board of Nobel Industries. Mr. Burgess has consented to retain his present position of general manager.

ON page 352 of our issue of March 27th mention was made of a fatal collision on March 15th between two engines which had been engaged in testing a bridge on the Goole and Selby Railway. In giving evidence at the coroner's inquest, on the 20th ultimo, the driver of the second engine said his instructions were to go over Newlands Bridge as fast as he could. His speedometer registered 90 miles an hour. On getting over the bridge he saw the first engine only a quarter of a mile distant. He expected it to be a mile away. He did everything to stop, but was unable to avoid the collision. The jury returned a verdict of accidental death.

THE annual report of the Canadian National Railways for 1924, which was presented to the Dominion Parliament on April 13th, shows a deficit of 54,860,419 dollars, as compared with 51,697,674 dollars for 1923. Operating revenues were 235,588,182 dollars, as compared with 253,135,487 dollars for 1923, being a decrease of 17,547,305 dollars; and operating expenses were 218,343,931 dollars, as compared with 232,704,338 dollars, a decrease of 14,360,907. The net profits before fixed charges were 14,772,327 dollars, compared with 13,501,649 dollars. The fixed charges were 69,632,747 dollars, an increase of 4,433,423 dollars over the previous year.

AN entirely unforeseen situation has arisen in connection with the projected construction of a branch of the Timiskaming and Northern Ontario Railway into the Rouyn goldfield of North-Western Quebec. The Ontario Government had called for tenders for the construction of a line from the present terminus of the Larder Lake branch of the line into the Rouyn gold area, 37 miles of the route being within the province of Quebec, and running through Crown lands owned by that province. When negotiations were opened to secure the necessary right of way, Premier Taschereau, of Quebec, definitely stated that it would not be granted, and that his Government would do everything in its power to prevent the Ontario line coming into Quebec, as it was determined to keep the traffic of the goldfields within the province, instead of its being diverted to Toronto. At a later interview with Hon. Charles McCrea, Ontario Minister of Mines, Premier Taschereau reiterated his former decision, stating that a branch line would be constructed this season, from O'Brien, on the Transcontinental line of the Canadian National Railways, into the Rouyn district, bringing the trade of the district to Quebec or Montreal.

As the report by Lieutenant-Colonel Mount on the buffer stop collision of January 24th at Glasgow Central Station, London, Midland and Scottish Railway, might be construed as a failure of the Westinghouse brake, it is important to note that it was the maintenance of the brake that was at fault. The train was a football special, and consisted of twelve six-wheeled vehicles, of a total weight of 161½ tons, drawn by a 4–4–0 type tank engine, weighing 50½ tons. It was stabled at Law Junction during the week, and used only on Saturdays to deal with local football and other traffic. After the accident it was found that the brake was not available upon one coach of the train, and, when the carriages were loaded, was practically valueless on two others. The driver had been mainly employed in shunting work in and round Glasgow, and though he had occasionally worked loaded trains into that station he was not used to handling one as heavily laden as that in question. He was, moreover, unaware that probably 25 per cent. of the coaches, which carried many standing passengers, could not be counted upon as effective for braking purposes. The consequence was that his train ran into the buffer stops, and 48 passengers were sufficiently injured to require attention at the infirmary. These results might probably not have been so serious but for the condition of the rolling stock. All the carriages but one that was new in 1891, were built in the 'eighties, and the leading brake composite was fifty-three years old and had a headstock only 3½in. thick. The hydraulic buffer stops were undamaged. They were of the heavy type, with pistons of 7in. diameter and 7ft. stroke, working in 17in. cylinders.

Notes and Memoranda.

WITHIN recent times the single-deck motor omnibuses plying in Shanghai have each been carrying over 17,600 passengers a month.

DURING March the Taiyo Maru, a Japanese ship of 22,000 tons, was taken right up the Whangpoo River to Shanghai. She is 580ft. long and draws 35ft. of water.

THE carillon of bells which has just been cast by Messrs. Gillett and Johnston, of Croydon, for the Park-avenue Baptist Church, New York, is the largest in the world. It comprises fifty-three bells, ranging in weight from 15 lb. up to 9¼ tons.

AT present no iron ore is being mined in the province of Ontario, but large steel works are in operation on imported ore. There is, according to *Canada*, a great opportunity for capital scientifically employed to open up some of the big iron ranges known to exist.

THE whole of the main underground haulage plant at the Wearmouth and Hylton collieries has now been electrified. The supplies are taken from the Durham Electric Power Supply Company and the Sunderland Corporation at pressures of 20,000 and 5000 volts respectively. Local transformers reduce these pressures to 2200 and 2750 volts.

A POSSIBLE cause of explosions in electrical conduits is suggested by Mr. A. Forshaw, of Falkirk, in a letter to the *Gas Journal*, to be the presence of metallic sodium produced by the electrolysis of some sodium salt contained in the materials of the conduit by stray currents from a fault in the cable. Mr. Forshaw has actually identified the presence of traces of sodium metal in one instance.

AT a recent meeting of the American Chemical Society, at Baltimore, a number of papers were read dealing with the nature and prevention of corrosion. Opinion was in favour of the electro-chemical theory, most prominently advanced in this country by Mr. O. R. Evans, of Cambridge. Among the remedies discussed were the use of alloys, the removal of air from water in pipes, and the induction of slight films of corrosion of a type which will resist further electro-chemical action.

PRIOR to 1902 all the Portland cement used in New South Wales had to be imported, but last year the local production amounted to 223,000 tons, as against 1500 tons imported. Within the past twenty-five years the value of the annual production of limestone and its products throughout the state has risen from an insignificant amount until now it exceeds £1,000,000 per annum, ranking fourth in importance of the economic minerals. It is considered that it will occupy the position next in importance to coal.

ATTENTION has lately been given, states *Machinery*, to the formation on metal surfaces that have to withstand high temperature, of a layer of aluminium that alloys more or less with the body of the metal. Recently, a process has been developed in which castings can be poured in moulds containing a network of aluminium wires. The aluminium is absorbed and a hard alloy layer forms on the surface of the casting, which gives as good a protection against high temperatures as in the case of aluminium externally applied.

SOME experiments carried out by a Russian chemist, and quoted in the *Chemical Trade Journal* show that lime burned at 1100 deg. Cent. slakes the most rapidly; that burned at 1700 deg. Cent. is over-burned and slakes very slowly, even after prolonged contact with water. Lime produced by burning limestone (97.78 per cent. $CaCO_3$) hydrates more slowly than that from the oxalate heated to the same temperature, and though the optimum temperature was again 1100 deg., over-burning occurred at 1200 deg. The slaked lime, after being dehydrated, redissolved at the same rates as before.

ACCORDING to the *Iron Age*, plaster on metal lath has proved to be the best and most serviceable material for protecting structural steel work against fire. Plaster on ordinary surfaces has no fire-protective value. Ordinary adhesion is not sufficient to withstand the stresses resulting from high temperatures. When applied to metal lath, a different condition exists; a mechanical bond is secured. The plaster is not only held to its work, but is reinforced in every direction against the temperature stresses. The result is a tenacity and durability beyond that of any other combination of materials.

THE production of sponge iron, a form of the metal very useful in chemical and metallurgical industry, has been made possible on a large scale by researches conducted at Seattle by the Bureau of Mines of the United States Department of the Interior. The process depends on the fact that most iron ores are oxides of iron, and that if the oxygen can be extracted at temperatures so low that the iron does not fuse, there is left a very fine porous metallic sponge, presenting very large areas of free surface. The process also promises to render possible the profitable production of iron from low-grade ores and furnace wastes. During the past year a furnace using the new process was operated commercially at Silver City, Utah, producing about 3 tons of sponge iron daily.

THE Canadian natural gas industry is second only to that of the United States, the annual production in the former country amounting to some 20,000 million cubic feet, valued at 5 million dollars. The bulk of this gas comes from the provinces of Alberta and Ontario, but there are already signs of exhaustion in the eastern fields, and steps are being taken to conserve the remaining resources and to regulate the supply. In Alberta the position is different, since several large flows have recently been struck, and there are also many potentially favourable areas which have not been explored. Much of the Alberta natural gas is apparently a dry gas, so that petrol extraction has not on the whole assumed the importance in the Canadian gas industry that it has done in the United States; one area, however, that of Turner Valley, yields a wet gas capable of giving from 0.2 to 0.7 gallon of petrol per 1000 cubic feet of gas, which compares favourably with some of the results achieved in the mid-continent region of America. It seems unthinkable that helium should be allowed to go to waste in view of its enormous value for aircraft purposes, but such is largely the case in Canada at the present time.

Miscellanea.

ANOTHER one million-bushel grain elevator is to be put up at Owen Sound, Ontario.

THE tenth of the German destroyers sunk in Scapa Flow was raised by Messrs. Cox and Danks on May 1st.

THE order for 500 railway freight wagons needed for the Egyptian State Railways is said to have been placed in Prague.

SOME new regulations for the verification of weights have been put into force at the National Physical Laboratory.

IT is proposed to expend about 330 lakhs of rupees on the electrification and doubling of the railway lines in the suburbs of Madras.

THE Chefoo Harbour Improvement Commission proposes to construct two all-steel single-storey pitch-roof cargo sheds, 200ft. long.

THE Port of London Authority has approved a scheme for the improvement of the India and Millwall Docks, at an estimated cost of £1,030,000.

ACCORDING to the daily Press, there is a possibility of coal being mined near Winslow, Buckinghamshire, but no precise information is yet available.

THE Birmingham and Midland Building and Allied Trades' Exhibition is to be held in the Bingley Hall, Birmingham, from September 7th to 19th.

WORK is to be started very shortly on the construction by a British firm of a 28 miles long electric tramway outside Warsaw. The cost is put at £600,000.

IT is now expected that the great wireless transmitting station near Rugby will be ready for work by November. Eight of the twelve 820ft. masts are complete.

A CORROSION Institute has been formed in America by the collaboration of the Division of Industrial and Engineering Chemistry and the American Chemical Society.

IT is claimed that the flight made by the United States naval seaplane PN 9 on May 1st was a record for endurance. The machine was in the air for 28 hours 35½ minutes.

A FOURTH furnace has been put to work at the Odda carbide factory in Norway, and is being used for the manufacture of cyanamide. The production of ferro-silicon is also to be restarted.

WORK has been started on the 200ft. mast at Ismalia, Egypt, to which the airship R 36 is to be moored when she goes there. It is hoped that the ship will be ready just before Christmas.

ACCORDING to the *Ironmonger*, a Swedish engineer has discovered a method of extracting vanadium from iron ores, by means of which 100 tons of that metal can be recovered annually in Sweden.

THE Manchester Waterworks fourth pipe line from Thirlmere to the city has just been completed, and will shortly be tested, but it will not be brought into continuous operation for about a year.

THE Foundry Trades' Equipment and Supplies Association has been registered as a company limited by guarantee and not having a capital. The registered office is at Avenue Chambers, Southampton-row, W.C. 1.

POWER was supplied from the Workington Electric Power Company's station at Siddick Colliery for the first time on April 30th. The power is generated by means of waste heat from the St. Helen's Company's collieries.

THE Canadian Pacific Railway has completed the work of lining the Connaught Tunnel under Mount MacDonald, in the Rocky Mountains. Nearly half a million sacks of cement were used for the lining, which is 12in. thick. The tunnel is 5 miles long.

AN agreement has just been concluded between Vickers Ltd. and the Soviet Government for the erection of an oil cracking plant at Baku for converting mazout into benzine. While a certain amount of oil refining has already been carried out at Baku, it is believed that this is the first time that a plant for oil cracking has been set up there.

ON Wednesday next, at 8 p.m., before a joint meeting of the Royal Society of Arts, the Royal Aeronautical Society, and the Anglo-Batavian Society, to be held in the Royal Society of Arts' building, John-street, Adelphi, London, W.C. 2, Mr. Thomassen à Thuessink van der Hoop will read, in English, a paper on "The Non-stop Flight to the Netherlands East Indies."

ACCORDING to the *Chemical Trade Journal*, four additional Casale nitrogen units, each of a capacity of 7½ tons per day have been ordered for erection in Japan. Four similar units are already in operation in the country, and when the new units commence to manufacture the total annual producing capacity of Japan for synthetic ammonia by the Casale process will be 20,000 tons.

THE Berlin newspapers report that in order to gain further practical experience of the Flettner rotor, the Naval Administration, in agreement with the German Shipowners' Union, has undertaken to construct the first large Rotor cargo ship. The Naval Administration, with the participation of the Robert M. Sloman, jun. firm of Hamburg, has placed an order with the Weser concern for a 3000-ton Rotor ship, which is to be delivered in about twelve months.

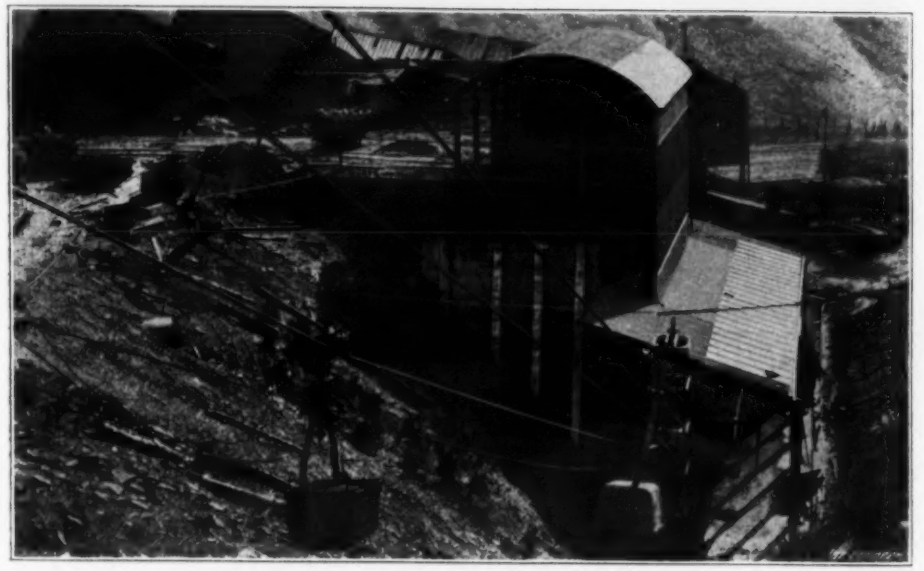
A NEW "safety first" device has been invented by two members of the engineering staff of J. Lyons and Co., Ltd. It consists of a warning to impetuous motorists, and is designed to minimise the danger of accidents in the Hammersmith-road, near Cadby Hall, whence several hundred vans, wagons and lorries emerge in the course of a day. As a lorry or van slowly leaves Cadby Hall yard, it crosses a "strip" set in the roadway in the archway, the pressure on the strip is magnified so that a switch is set in operation. At once a model of a Lyons' van runs out on a rail, so that it is distinctly seen by drivers of vehicles in the main road. The model goes out well in advance of the emerging lorry, and simultaneously three shrieks of a Klaxon horn give the warning to traffic. At night the model is flooded with a red light.

STEEP COLLIERY ROPEWAYS IN SOUTH WALES

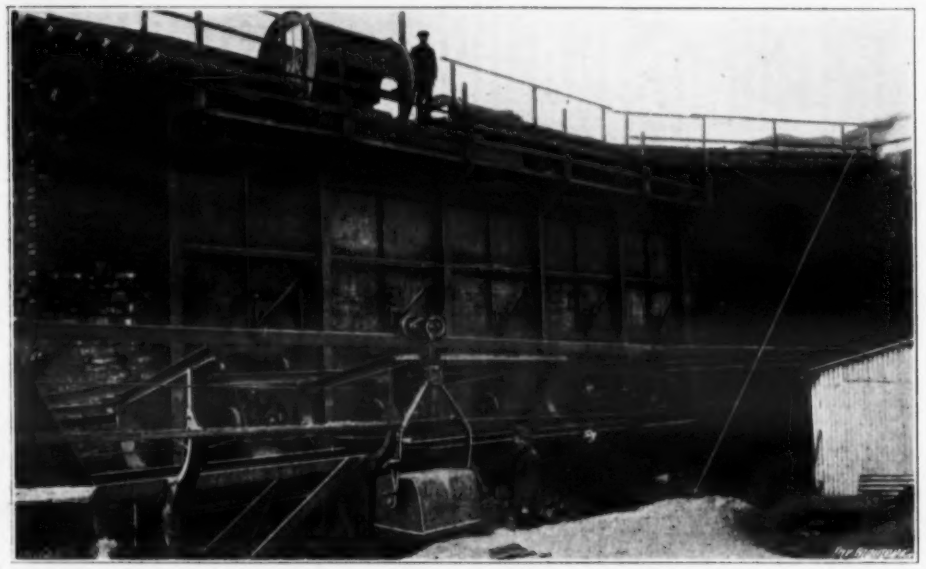
R. WHITE AND SONS, WIDNES, ENGINEERS

(*For description see page 514*)

ROAD CROSSING ON WYNDHAM ROPEWAY



LOADING TERMINAL OF WYNDHAM ROPEWAY



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TWO-PAGE SUPPLEMENT—SOME STEEP COLLIERY ROPEWAYS IN SOUTH WALES.

ERRATUM.

Owing to a misprint, the grate area of the Great Northern engine Flying Fox was given in our leading article last week as 44½ square feet. The correct figure is 41½ square feet.

THE ENGINEER.

MAY 8, 1925.

A Notable Railway Appointment.

NOT since the appointment of the general superintendent of the Long Island Railroad to the position of general manager of the Great Eastern Railway in February, 1914, has the railway world been so startled as it was by the announcement made last Friday that Sir Josiah Stamp was to fill a newly created post of President of the Executive of the London, Midland and Scottish Railway. There is a certain parallel between the present selection and that of Mr. (afterwards Sir) Henry Thornton. Commenting at the time on that event, we said, in THE ENGINEER of February 20th, 1914: "But whilst we give Mr. Thornton a cordial welcome here, more particularly because he is an engineer as well as a railway manager, we must protest against the manner of his introduction. Lord Claud Hamilton has put a slight, not only upon all the men whom it was his business to train up, but upon the men of other railways. The Great Eastern must, indeed, require reorganisation if it be really true that no man in its service could be found to undertake the general managership." Naturally, therefore, our first thoughts on hearing the present announcement prompted the question why it had been necessary to go outside British railway circles to find a man possessing the breadth of view that, as we shall explain in a moment, obviously is the main qualification necessary for this new position. Such a thought casts no reflection on Sir Josiah's abilities, as they are unquestioned, and his appointment will be a source of strength to a much-tried concern. What we are anxious about is the discouragement it brings to railway officers. The Railways Act, because of the compulsory amalgamations it enforced, has taken the heart out of many a man. It has scotched his opportunity, and killed his desire to do well for himself and for his company, and has wrecked hundreds of careers by closing the avenue to promotion. When the companies were more numerous and of a less size there was a greater opportunity for men to make themselves useful in varied directions. That no longer is the case. There is, again, less chance for a man to have his talents revealed to the powers-that-be. Altogether, then, railways as a career have lost their attraction for the young men of this country, and the present appointment, by the suggestion it conveys as to a scarcity of able railwaymen, has made the prospects worse.

We do not in the least criticise the wisdom of creating such a post as that of president, and still less do we object to the high salary that the new incumbent must ask for his services. Actually, we consider that the appointment is really required, and in order that we may give our reasons for this belief, it is necessary first to observe that the parallel, drawn by the Press generally, with the position of President found on all the railways of the United States does not apply. On our railways there has always been a board of directors and a chairman, together with a general manager. In the United States there is rarely a general manager, and yet more rarely a chairman; both these offices are combined in that of President, who is a practical railwayman, and not only the chief of the board, but the head of the administration. Now, the present official announcement says that Sir Josiah is to be the President of the Executive. From that statement we take it that Sir Guy Granet will remain the chairman and that the directors will continue to act by means of committees, and the board, but that the chief officer of the company will be the President. That assumption is strengthened by the public notice further observing that Mr. Burgess has consented to retain his present position of general manager. Again referring to the official announcement, we observe the expression that the new departure is the result of "the experience of amalgamation." It has, let us remark, long been known that a spirit of unrest has permeated, not only the rank and file of the London, Midland and Scottish Railway, but that even the incumbents of some of the highest posts are not quite happy in their surroundings. Sir Guy Granet, speaking at the Weavers' Company in November last, said that "some square pegs have gone into round holes," and from the chair at the annual meeting of the railway company on February 27th he also remarked that "one other internal trouble has been the difficulty, inherent to so large an amalgamation, of setting our machine on right lines and getting it to work sweetly." It cannot have passed unnoticed that the other big grouped company, the London and North-Eastern, has experienced few such troubles. The reason we give for that happier result is that put forward in a leading article in THE ENGINEER of December 26th last. It is that that line has been divided into a Southern, a North-Eastern and a Scottish area, and except that the Great Northern, Great Eastern and Great Central are combined to form the first-named division, the inter-relations between the officers and the staff and between the company's servants generally and the public are little changed. In a sense, business is carried on as usual, but under a new proprietorship. But that company's western neighbour, before it had settled down after absorbing the Lancashire and Yorkshire, had to adjust its methods to, and walk in step with, the Midland, and, in addition, to administer the larger half of the Scottish railways. As soon as so big an undertaking was created, a weakness, long experienced on British railways, but not always evident, became serious. It must be remembered that in the early days of railways the engineer filled the most important post. As the need for gaining and retaining traffic grew, the importance of the office of general manager increased until in time he became equal in standing with the engineer. But of recent years the general manager, possibly with some advantage, has become the chief administrative officer. Now, all the general managers of the present four chief companies have been trained on the "traffic" side, and necessarily they may be lacking in a full sympathy with engineering experience. When, as now, the time arrives for important decisions as to the future policy in many technical questions—such as, possibly, whether the track and bridges shall be strengthened to carry heavier locomotives, or whether the latter shall continue to conform to a maximum of, say, 20 tons on an axle—it is important that the decision should be in the hands of one who can correctly gauge the benefits and the disadvantages, and truly weigh the one against the other. It will be amongst the duties of Sir Josiah Stamp to settle such questions. He may be without any engineering training, but he will be able to bring an impartial mind to bear on such questions, and a capacity to draw conclusions and to arrive at a sound judgment.

There is, we frankly confess, another side to this question. The railways of this country are at present in a very parlous state. The traffic receipts this year are less than those of a year ago, and therefore much less than in 1923. At present there are no signs of their improving, even to the extent of being on a level with last year. Despite this fact, competition in the way of train services

and for the comfort of passengers was never keener than now. Naturally, the companies look to their wages bill as a source wherein economies can be effected. But, thanks to the irresponsible recklessness of the Government in the war control period, the men are now so deeply entrenched and the companies so tied by agreements that it is almost hopeless to expect much from any savings in labour charges. The companies comfort themselves somewhat with the knowledge that the Railways Act practically sanctions rates and charges that will ensure them the same net revenue as in 1913. It is, however, clear that such prices may then be higher than the traffic will bear, and thus the anticipated income may not materialise. Thus, the railways to-day are faced with serious problems, and, beyond the reason we have given, there may be wisdom in the appointment of so eminent an economist as Sir Josiah Stamp. He will bring a wide and varied experience, acquired by twenty years in civil service and for the last five years with the Nobel Industries, which may prove to be the salvation of the railways. It is an old truth, yet the truth still, that prosperous railways mean a prosperous country.

Insulation.

SPEAKING at one of the Institution of Electrical Engineers' Commemoration Meetings, held in 1922, Dr. Ferranti said that the principal difficulty in the early days was the lack of insulating materials. Those who have embarked upon electrical work within more recent times can perhaps scarcely imagine what a handicap to the pioneers this absence of good insulation was, or how much time and thought had to be devoted to the problem of discovering what could and could not be used. Finally, it was found that such common things as brown paper and the refuse from the wax candle industry could be employed, and with these materials Dr. Ferranti constructed 10,000-volt alternating-current cables, which are in use to this day. Great attention has since been given to the study of insulation, but it was shown in a paper read before the Institution of Electrical Engineers recently by Messrs. K. G. Maxwell and Allan Monkhouse, that during the past twenty years singularly little change has been observable in the general nature of insulating materials. On the other hand, the past few years have been marked by a clearer understanding of the theories of insulation, which has resulted in a more scientific use of the materials available. Better knowledge has also been gained of the properties of various insulators under extreme thermal, mechanical and electrical conditions. There has, moreover, been a definite movement in the direction of developing standardised methods of ascertaining and expressing values for the properties of insulators, an organised effort to produce refinements in the quality, and improvements in the method of applying insulating materials in the electrical manufacturer's works.

While much has been published on the behaviour of dielectrics under electrical stress, a fair portion of the information is more of academic interest than of actual practical value, and for this reason the paper to which we have alluded will not, we think, fail to create interest, for it contains much which concerns those who are engaged in electrical factories, and who are anxious to learn all they can about the practical application of insulation. Research has resulted in perfectly definite conclusions being reached as to the relative superiority of various commercial vegetable fibres for electrical work, and also as to the most suitable methods of converting them into boards for the requirements of the industry. A very great deal of useful knowledge about dielectrics has, in fact, been derived from scientific investigation, but much still remains to be learnt. Experience has served to confirm, states the fourth annual report of the British Electrical and Allied Research Association, the importance of conducting a comprehensive scientific research into the phenomena of insulation, as being in the long run the most economical and most effective method of improving materials and practice. That there is ample scope for such improvement is shown by the wide range of quality of existing materials, by the advances already made through the investigations that have been conducted under conditions of severely restricted finance, by the large factors of safety which designers still find necessary in utilising existing data, and by the efforts being made in competing countries in the same direction. The matter is one which not only affects the manufacturer and exporter, but the whole industry and all users of electrical apparatus, and will need to be financed on a much larger scale than hitherto. An interesting and important branch of the subject is the study of dielectrics in relation to super-pressure cables, but to this matter Messrs. Maxwell and Monkhouse gave little attention, beyond stating that for cable work paper insulation has definitely established itself and development is now proceeding on the lines of improved treatment of the paper to produce dielectrics commercially for the high voltages now being employed. A great deal has, however, been said and written about cable dielectrics, and a few weeks ago Mr. A. I. Tracey, of Johnson and Phillips, Ltd., delivered an instructive lecture on the subject before the Power Engineers' Association. Although new ideas were not introduced, the lecturer made a very successful attempt to present in a concise manner a few of the outstanding facts which have a big influence on the design and manufacture of super-tension cables. It is to be hoped, however, that in tackling the problem of designing cables for voltages higher than those that are commonly applied to cables, engineers will not hesitate to depart from conventional ideas if there is reason to believe that an entirely new method would prove beneficial. There is sometimes a tendency, we fear, to scoff at suggestions which do not comply in any shape or form with present-day practice, and which, if adopted, would completely upset existing workshop arrangements. Suggestions that come from professors and others who are not directly associated with practical engineering often prove valueless, although they may be quite sound from a theoretical point of view. But however revolutionary and impracticable it might appear, every proposal should have the fullest consideration of those who specialise in the particular class of work concerned.

Speaking at a meeting of the Institution of Electrical Engineers in 1922, Professor Fleming referred to the fact that an insulator of high electric strength has, with one exception, a high dielectric constant, the exception being compressed air. The electric strength of air increases almost proportionally with the pressure, whilst the dielectric constant does not increase much above unity, and on these grounds Professor Fleming suggested that it might be possible to transmit current at high pressures by means of a copper rod covered with solid insulation, and fitting concentrically and with clearance within a copper tube, which would act as a return and which would be placed in a steel tube filled with air at a pressure of 150 lb. per square inch. An experiment of that kind, it was suggested, might be carried out on a fairly large scale, in order to discover whether with highly compressed air it would not be possible to derive the advantage of high electric strength with a small dielectric constant, and therefore small capacity currents. Mr. J. S. Highfield, who spoke later, said that he had already tried the idea, and had found that with an air pressure of from 100 lb. to 150 lb. per square inch inside the steel tube there was no difficulty whatever in transmitting alternating current with a pressure of 60,000 volts between the conductors; but why the scheme was not permanently employed Mr. Highfield did not say. Probably the cable manufacturers can quite easily give reasons for not adopting the idea. Let it be realised, however, that for super-pressure work, some entirely new form of cable may ultimately have to be developed. Revolutionary proposals such as that from Professor Fleming are very apt to cause alarm, but it is a pity, in our opinion, that they are not put forward at more frequent intervals.

Heat Engine Trials Committee.

ON Wednesday evening a joint meeting was held, under the chairmanship of Captain H. Riall Sankey, at the Institution of Civil Engineers, London, for the purpose of discussing a proposed code for recording the results of heavy-oil engine trials. The code, prepared by the Heat-Engine Trials Committee, was introduced by Mr. James Carnaghan. As submitted at the meeting the code was intended to cover all the necessary information for a comprehensive trial. Items considered to be essential for a trial for industrial purposes were indicated with asterisks. The object of combining the two classes of code in one document was to promote the facility of discussing them. It is intended that the industrial trial code when approved shall be published separately. The draft code was accompanied by explanatory notes defining or explaining certain of the required entries.

We are precluded from publishing the draft code, but it may be stated that it is arranged in five parts. In the first provision is made for the insertion of general information, design data, and a detailed description of the engine. In the second a statement of the methods employed for the measurement of the fuel, air and cooling medium consumption, the brake horse-power, and other items is provided for. The third section is intended for the tabulation of mean observations derived from the log-sheets and of certain preliminary deductions. In the fourth space is provided for the insertion of final deductions as to the fuel consumption per indicated horse-power per hour, the thermal efficiency, and so forth. The fifth section presents the heat account in tabular form.

In his introductory remarks, Mr. Carnaghan stated that certain matters bearing on the code were being dealt with separately, and would be submitted for discussion in due course. These matters were:—(*a*) Calorific values, temperatures and pressures; (*b*) methods of measurement and use of instruments; (*c*) definitions and values of fundamental data; and (*d*) governor tests. It was recognised, he said, that it was not possible to provide in the code for extreme cases of divergence from general design in heavy-oil engines, but, as far as possible, provision had been made in the standard form for the deletion or insertion of unnecessary or additional details.

Sir Ernest Petter opened the discussion. He urged that the recording of the results of heavy-oil engine trials should be divided into three classes, namely, as regarded:—(*a*) High-power engines for power station and marine work—engines, for example, of the self-ignition type of 500 brake horse-power and upwards; (*b*) medium power engines for high-class industrial work and for small power stations and ships, including heavy-oil engines of 200–500 brake horse-power of all types; and (*c*) small engines for general industrial and marine purposes, as, for example, heavy-oil engines up to 200 brake horse-power. The trial results for these three classes should, he argued, be varied according to the amount of work involved in the factory in obtaining them, and according to the results required by the purchaser. The first class would warrant a fairly comprehensive trial, for such a trial would not add materially to the production cost of the engine. Not quite so comprehensive a trial would be justified in the second class, but in the third class, manufactured more or less on mass production lines, the cost of anything like a comprehensive trial would be excessive relatively to the cost of making the engine. All that could be commercially determined for such engines would be the horse-power, and the fuel and lubricating oil consumptions. After some detailed criticism of the items of the code, Sir Ernest suggested that it was most important that some ruling should be laid down regarding the definition of the term manufacturer's rating. He was satisfied that American and continental practice in this matter did not conform with British practice. He thought that the B.E.S.A. definitions of rated output and margin of capacity, as given in the standard specification for heavy-oil engines for electrical purposes, might be adopted.

Mr. B. Pochobradsky agreed with Sir Ernest Petter that the detailed particulars scheduled in the proposed code were too elaborate for industrial tests. Conditions might vary with the output of the engine, but they also varied with the purpose for which the engine was built and the guarantees given by the makers. He then outlined items which he held ought to be omitted from Part I. of the code, particulars which would leave the minimum data necessary for an industrial test. He generally agreed with Part II., but in Part III., under the heading of fuel, he thought it was desirable that the net calorific value should be stated in addition to the gross value. The performance of any engine really depended more upon the net than upon the gross value of the fuel used. For the industrial test it would also be useful to specify an accompanying diagram, which would show at a glance the total output, the oil consumed per brake horse-power hour and the efficiencies worked out, both on the basis of the indicated and the brake horse-powers. With regard to the comprehensive test, he suggested that the net calorific value of the fuel should again be stated, and also that the temperature of various parts of the engine, such as cylinder covers, jackets, bearings, &c., should be recorded. Such observations might not be important as regarded the main test, but they did give valuable information from the point of view of design, and allowed the heat losses to be computed.

Engineer-Commander Tostevin said that in endeavouring to fill in the code with the actual results obtained from an oil engine trial, he had found that certain of the items specified were not free from ambiguity. He suggested that as many engines were made in this country under continental licences, provision should be made in the code for recording the dimensions and quantities in metric units.

Mr. F. H. Livens endorsed the plea for the simplification of the code for the testing of small sizes of engine. He did not doubt that large engines were more in the mind of the Committee than were small units when the code was drafted. There was room, he thought, for a separate and smaller code designed to meet the conditions for small engines, but it should take into account differences of opinion which undoubtedly existed regarding the carrying out of such tests. The modified code should be made as practical as possible, for the use of manufacturers, and might

include engines from, say, 50 up to 200 brake horse-power. He had little to say regarding the main body of the code and the recommendations made, except that he thought that the net calorific value of the fuel used might be stated, as that value was very much used elsewhere. Further stress might be laid on the taking of the viscosity of the oil in the case of the industrial test.

Mr. C. W. J. Taffs referred to the means of collecting the samples of the fuel, and said that it was not sufficient merely to plunge a bottle in the supply tank. A slow continuous supply should be allowed to dribble from the supply pipe, and collection spread over a considerable length of time. Most Diesel oils, he explained, were mixtures, and if left to themselves stratified, so that a sample quickly obtained in a bottle might fail to give anything like a true indication of the average character of the fuel. He urged that the specific gravity of the fuel should be given, not at one but at four temperatures, ranging from 40 deg. to 160 deg. Cent., so that the consumption might be determined by volumetric rather than gravimetric methods.

Mr. W. H. Patchell discussed the question of calorific values. He reminded those present that at a meeting of the Boiler Trials Committee, at which some American engineers were present, it was decided to use the gross calorific value. Engineers on the Continent had also swung from the net value to the gross value, and he thought that the present Committee should adhere to its determination to use the gross value, but the net value might also be stated, as its partial use, if retained, might stimulate chemists and physicists to introduce new and improved methods of determining the net calorific value of a fuel. Referring to some of the remarks of previous speakers, he did not think that the codes under discussion were ever meant to be applied to engines made under mass production methods. For testing such engines a simple electric brake was, after all, the best method.

Mr. W. A. Tookey, dealing also with the question of calorific value, said that whether a high calorific value gas, such as town's gas, or a low value one, such as producer gas, was being used, the difference between gross and net value was remarkably constant at between 9 and 10 per cent. For oil the difference was about 7½ per cent. He suggested, therefore, that as the determination of net calorific value took a long time, longer perhaps than the whole of the rest of the test of the engine, it might be desirable if the Committee were to lay it down that the net value might be determined by deducting 7½ or 10 per cent. from the gross value.

Mr. R. H. Parsons expressed the hope that no such rough-and-ready rule would be sanctioned, and illustrated how misleading it might be by applying it to the case of a gas containing, say, 90 per cent. of methane. Mr. Tookey objected that his remark was not meant to apply to a gas of 1000 B.Th.U. calorific value or thereabouts.

Mr. L. Pendred, referring to Mr. Taffs' remarks on the testing of oil fuel, expressed the hope that it would be found possible to adhere to one standard method, and that that method would be the existing one specified by the B.E.S.A.

Major Owen asked if the expression industrial tests was intended to include acceptance tests. Captain Sankey explained that the precise designations to be given to the two forms of test had been discussed by by the Committee *ad nauseam*. They had started with scientific and commercial, but finally concluded that comprehensive and industrial best expressed what they had in mind.

Mr. J. L. Chaloner said that the various codes might be classified on the lines of the nature of the test to be carried out. He called attention to the many excellent works test sheets which were used by British manufacturers, and asked if the Committee had studied them, with a view to reducing the time expended and the cost of a short commercial test. There was room for a short test, and it was essential. With regard to the question of calorific values, he thought that the gross value should be used, but the net value should also be stated. The latter value came prominently into question when the exhaust gases were used for heating purposes. The gross value was standardised in America, and it had been adopted in the B.E.S.A. specification.

Mr. Carnaghan, in replying to the various points raised in the discussion, stated that he thought every point dealt with had been discussed by the Committee, but he felt sure that the Committee would gladly go over the ground again. With regard to Mr. Chalbner's suggestion regarding the perusal of works test sheets, he stated that a large number of such test sheets had been considered. The question of expressing the main test results in graphical form had also been considered, and would be again taken up. With regard to the different methods of sampling oil, referred to by Mr. Taffs, he felt that the Committee would be wise in following the recommendations laid down by the Institution of Petroleum Technologists and approved as the British Standard by the B.E.S.A. Committee.

THE Algoma Steel Corporation, Ontario, established a new record recently by rolling 35,099 tons of steel rails in one month.

Obituary.

D. B. MORISON.

ALL who knew him will hear with sincere regret of the sudden death at the age of sixty-seven of Mr. D. B. Morison at Nice on April 30th. Mr. Morison's health had been far from good for some time, and he had found it necessary to relinquish some of his cares and duties and take a rest abroad. The change had done him good, and he was even making arrangements to return home. As chairman and managing director of Richardsons, Westgarth and Co., Ltd., for many years, Mr. Morison was known throughout the world as an expert on marine engine design, but he will probably be remembered by his devotion to the subject of steam condensers and marine auxiliaries. It will be recalled that we owe to him the early development of the Contraflo type of condenser, and his suspension furnace is too well known to require mention. He was the inventor of the "Loek-fast" welded shaft for steamships, and of late years gave much time to the design of de-aeration plants for boiler feed.

Mr. Morison served his time at John Elders and went to sea as fifth engineer in the ill-fated Austral. He was on board when she sank in Sydney Harbour, and had a narrow escape from drowning. Although a junior engineer, he was instructed to stand by the ship during her repairs, and then came home with her.

He continued his professional career with Thomas

DONALD BARNS MORISON

Richardson and Sons, of Hartlepool, and showed such ability that, at the early age of twenty-six, he was made manager of the firm. When the amalgamation with Westgarths took place in 1900, he became joint managing director, later sole managing director, and, finally, on the death of Mr. W. J. Richardson, chairman of the company. He brought to his work not only expert knowledge of a high order, combined with a sound practical engineering sense, but a commercial clearness of vision and energy which put his company in an enviable position. Whilst of late years the company took up the manufacture of steam turbines of the Brown Boveri and Brown Curtis and other types, principally for land work, it held fast to the reciprocating marine engine, of which it turned out large numbers, and in one year established a record by completing fifty sets. Then, when it saw the advent of the oil marine engine, it added it to its products. It is fitting to recall here that the initiation of the Marine Oil Engine Trials Committee is due to Mr. Morison, whose firm not only made a very handsome donation to the funds, but put a ship, the Sycamore, at the disposal of the Committee. This step led to other firms agreeing to submit engines and ships to similar investigations. Mr. Morison was originally on the Committee, but very properly withdrew when the Sycamore was submitted for trial.

Mr. Morison was a member of a good many societies and institutions, and sat on the Councils of the Institutions of Mechanical Engineers and Naval Architects. At one time he contributed papers freely, and his communications to the Institution of Naval Architects and the North-East Coast Institution are remembered by all who follow the development of the condenser and its accessories.

In the interests of research he initiated a scheme adopted by the North-East Coast Institution of Engineers and Shipbuilders, whilst in the direction of standardisation may be mentioned his advocacy of the unification of the rules for boiler design. Among his other activities may be noted Mr. Morison's campaign on behalf of the engineer officers of the Navy. As a result of that campaign engineer officers in the Navy were, in 1916, given military status. In connection with Richardsons, Westgarth and Co., Ltd., Mr. Morison introduced various schemes having for their object the well-being of the employees. Among these was the apprentice advancement scheme, which he inaugurated over twenty years ago, and in connection with which he last year established the D. B. Morison Engineering Scholarship. Again, through his initiative and Viscount Furness's generosity, Tunstall Court, a large mansion with extensive grounds, at West Hartlepool, was given to the company, for ultimate use as a welfare home. He also partly endowed a superannuation scheme for the benefit of the foremen and officials, this scheme being now known as the D. B. Morison, Richardsons, Westgarth Staff Benevolent Fund. He was known to a very large circle of engineers, and was respected by all as one who had made a distinct mark upon the development of British marine engineering.

SIXTY YEARS AGO.

SIXTY years ago the Skelmorlie measured mile was not in existence. A measured mile had been laid down in the Gareloch by Robert Napier, fifteen or twenty years previously, but although it possessed the advantage of being very nearly tideless, its use was at times attended by some risk, and it was latterly seldom or never employed as a trial course. The Clyde shipbuilders in 1865 were, indeed, in the habit of running their trial trips between the Cloch and the Cumbrae lights, a distance of 13·66 knots. Measured miles existed elsewhere, notably in the Thames and at Stoke s Bay. The Scottish shipbuilders and engineers were aggrieved at the position. They held, according to a leading article in our issue of May 5th, 1865, that the absence of a measured mile on the Clyde compelled them to compete on unfavourable terms with their rivals on the Thames. The reason was a brazen-faced one. "Jockeying" of the machinery on a measured mile trial was a recognised practice. It was regarded as perfectly legitimate to do everything possible to get the utmost out of the machinery during the few minutes' run over the mile, to cut off the feed, to stimulate the stokers to abnormal exertions, to conduct the trial with hardly sufficient load on board to prevent the ship from turning turtle, to put on an extra engine-room staff having the special duty of keeping the bearings cool, even to drench the coal with turpentine, and to miscalculate deliberately the average speed. These practices were recognised and allowed for. All, it was held, was fair in love, in war, and on the measured mile, and in the words of an old engineer, it was a clear flying in the face of Providence to neglect the opportunities which a measured mile trial provided. The grounds of the Scottish shipbuilders' complaint were that on the long trial trips which it was their custom to run they were denied almost all opportunity for "jockeying," with the result that the speed of ocean steamers as deduced from Clyde trials was often below that of similar ships built and tested in other waters. We expressed the opinion that the absence of a measured mile on the Clyde was the real reason why Clyde-built ships and engines enjoyed a reputation second to none. The long trials showed what a ship could be expected to do with her cargo on board and a thousand miles from land, and not what could be got out of her machinery as a maximum effort. We trusted that the day was far distant when the measured mile would supersede the run from the Cloch to the Cumbrae. In the very same issue we reported in a paragraph or two the presentation of Rankine's paper "On the Mechanical Principles of the Action of Propellers," before the Naval Architects. In that paper Professor Rankine exposed the falsity of the assumption that the reaction of a paddle float or screw was equivalent to the resistance of a surface of the same size and figure advancing through the water, and laid the foundations of the modern theory of ship propulsion. By so doing, he incidentally took an important step towards rehabilitating measured-mile trials, for with the proper understanding of the action of the propeller came the scientific testing of ship speeds, a development with which even the suspicion of "jockeying" was incompatible.

A NEW SIAMESE GUNBOAT.

A NEW gunboat for the Siamese Navy, named the Ratanakosindr, was launched at the High Walker shipyard of Sir W. G. Armstrong, Whitworth and Co., Ltd., Newcastle-on-Tyne, on April 21st, having been laid down on December 29th, 1924. She is due to be completed during August next. This ship, which is the first naval vessel to be constructed in Great Britain for any foreign Government since the war, has the following leading particulars:—Length between perpendiculars, 160ft.; beam, 37ft.; normal draught, 10ft. 9in.; normal displacement, 1000 tons. Protection is afforded by a nickel steel belt, 2½in. thick, amidships, tapering to 1½in. at bow and stern. Bulkheads of the same material, varying from 1in. to 2½in., have been worked into the structure. The upper deck is armoured with 1in. and ½in. high-tensile steel, with an extra thickness of 1½in. over the magazines. The barbette rings are built up of 2½in. nickel steel, and the funnel base is plated with ½in. armour. The conning-tower is a structure of cast steel, 4½in. thick. The propelling plant consists of triple-expansion engines operating twin screws, the cylinders having diameters of 10½in., 18in. and 30in. respectively, with a stroke of 22in. At 150 revolutions per minute they are designed to generate 850 indicated horse-power, giving a speed of 12 knots. The boilers, two in number, are of the water-tube three-drum type, burning oil. The working pressure is 225 lb., the heating surface 2470 square feet, and the combustion space 270 cubic feet. Stowage is provided for 96 tons of oil fuel. The vessel will be armed with two 6in. quick-firing guns, singly mounted in gun houses, one forward and one aft. Four 3in. anti-aircraft guns are also provided. The complement of the gunboat is about fifty-two officers and men.

New Wood-working Machines.

WE recently had an opportunity of inspecting a batch of new machines for wood working which have been designed and constructed to comply with modern requirements by Thomas Robinson and Son, Ltd., Rochdale. The machines comprise a universal wood worker, a mortising machine for railway carriage and wagon timbers, and a moulding machine for general saw mill use. Messrs. Robinson have, of course, made hundreds of tools for similar purposes prior to those we are about to describe, but none of the earlier machines embodied the refinements and improvements in detail which are now introduced with the object of giving the highest efficiency, ease of manipulation and all-round utility.

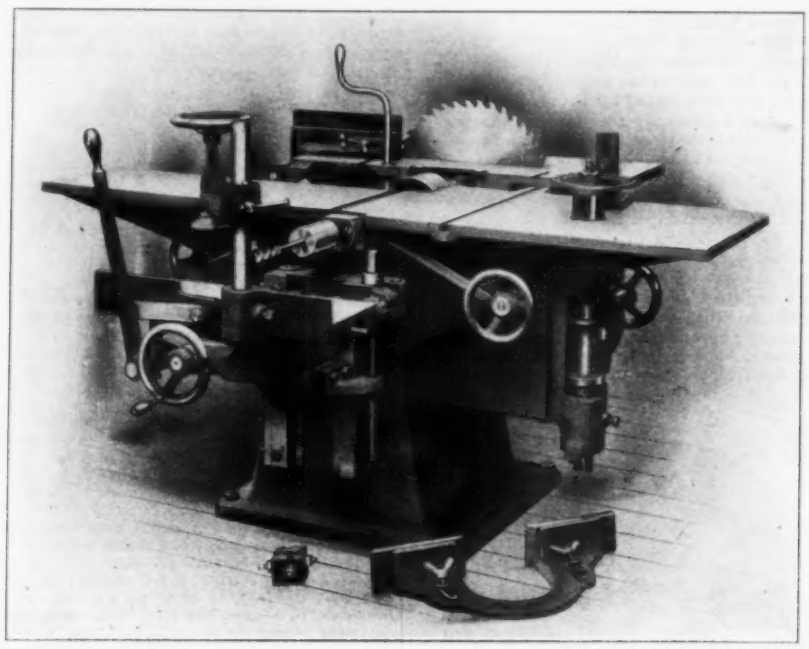


FIG. 1—UNIVERSAL WOOD WORKER

The universal wood worker shown in Fig. 1 is perhaps the most remarkable of the group for the number and variety of the operations which it is capable of performing. Within a small compass the machine embodies a hand planer, a saw bench with a rising and falling table, a circular moulding spindle attached to the front plate of the hand planer, a straight moulder with both power and hand feed, a tenoning apparatus, and a mortising and boring attachment, while by replacing an overhanging cutter block by a simple wooden drum, sand-papering can also be done. With the exception of the circular moulder, all the above units are operated by the hand planer spindle which is provided with two speeds and a reverse movement.

The machine is of extremely neat design, the two tables, 6ft. long overall, being carried on long inclined slides provided with steel lips to keep the gap over the cutters as small as possible. Planing, surfacing, jointing, rebating and chamfering are all performed on the main table, which is fitted with a canting fence, having parallel adjustment across the full width. On this table any width of timber up to 12in. can be dealt with. For continuous chamfering the front table is lowered to give the desired amount of cut, while for stop chamfering the back table is lowered to the same level as the front, in both cases the fence being canted and used as a guide. For tongueing, grooving, thicknessing, and moulding, the rising and falling table at the back of the machine is used, and the spindle is extended over the table to carry a cutter block, 5in. long. This block is used above the table for thicknessing and moulding, and below the table for tongueing and grooving. When it is desired to operate the cutter block below the table, a wooden filling-in piece is fitted in the gap, and the table is lowered on to the cutters until the latter cut their way through the wood. A cast iron plate is provided for filling in this gap when it is desired to work the cutter block above the table, and there are, of course, the necessary fence and "pressures" for guiding and holding the timber.

For making light mouldings and for thicknessing, the rising and falling table for the overhanging cutter block is provided with a light roller feed apparatus, which can be attached as required. It is driven separately by means of a belt and pulleys. Circular moulding is performed on the front portion of the planing table. The cutters are carried on the vertical spindle shown on the right-hand side of the machine. This spindle can be raised or lowered to adjust the cutters to suit the work. The spindle is driven from the main countershaft. In order to be able to use various types of cutters, the top end of the spindle is detachable, and cast iron rings are fitted in the table to suit various diameters of cutters. The hole in the table is filled up by means of a plate when the cutter is not in use.

For cutting tenons up to 5in. long the square cutter block on the horizontal spindle is replaced by a tenoning head. The timber is cramped on a sliding plate and passed under the tenoning cutter by hand feed. When one side of the tenon is cut, the table is raised above the cutter, and the process is repeated on the other side. The sliding plate on which the timber is clamped is fitted with a gauge bar and two adjustable stops, to determine the position of the shoulders and obviate marking out.

On the front of the machine will be seen a slot mortising and boring attachment, which will deal with timbers up to 8in. square and 6in. deep, the bit being carried in a chuck formed on an extension of the cutter spindle. The timber is cramped on a sliding table which has adjustment vertically by a hand wheel and screw, and is provided with adjustable stops for gauging the length and depth of the mortise. The complete attachment is easily locked in position or swung out of the way when the planing portion of the machine is in use. The machine will carry saws up to 24in. diameter. It is fitted with ball bearings to all revolving shafts, and the space occupied by the machine, including the countershaft, is only 14ft. by 3ft. 9in. by 5ft. 3in. Examples of work carried out on this machine are given in Fig. 2.

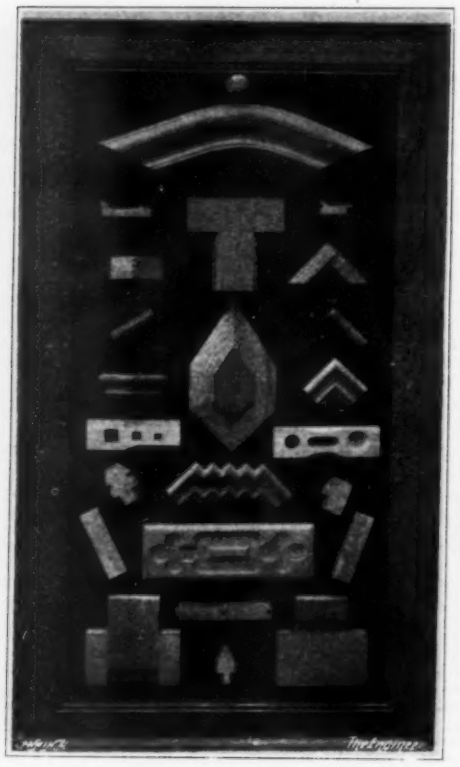


FIG. 2—EXAMPLES OF WORK

The operation of mortising railway carriage and wagon timbers is one which calls for high-class workmanship, rigidity and the best materials in the machines employed, as the hard nature of the timber used subjects the tools to unusual stresses. In the machine illustrated in Fig. 3 an auger revolving within a hollow chisel is used and is fed towards the work to cut a square hole in one movement, the operation being repeated sufficiently often to give the length of mortise required. The machine consists of a substantial cored base for supporting the table and mortising head. The latter carries the chisel and auger spindle, and can be moved horizontally in heavy V slides on a knee or headstock, which is arranged to rise and fall in vertical slides, the whole unit being counterbalanced for ease of manipulation by a weight suspended within the bed. The vertical adjustment is effected by means of the capstan wheel, rack and pinion shown, adjustable stops being provided to limit the travel and a locking device to hold the head in the required position. The reciprocating movement of the chisel is obtained from a square threaded screw connected through spur and bevel gearing to internally expanding friction clutches, which, together with the spur reduction gear, are enclosed in an oil bath gear box, shown in the base of the machine. The clutches are mounted on the high-speed shaft, the outer members being free and the expanding rings carried by an inner member, which is keyed to the driving shaft. The clutch rings are opened by toggles controlled by a sliding member common to both and operated by a rack and pinion, thus making it impossible for both clutches to be in gear simultaneously. The clutches are automatically controlled by means of a rod on the mortising head, fitted with adjustable knock-off stops, which ensure that the mortises are cut to a uniform depth, while the chisel is run continuously. To stop or start the chisel at any point, a hand lever is provided. Cone pulleys on the clutch driving shaft and machine countershaft give two forward and two quick reverse speeds. The auger spindle is mounted on heavy double-row ball bearings enclosed in dust-proof housings, and is driven by a belt from the countershaft at the side of the machine, a self-acting belt tightener being provided to compensate for the rise and fall of the headstock.

The table has compound movements on large square and rectangular slides, friction rollers being fitted at each end to assist in the handling of heavy timbers. Longitudinal travel of the table is brought about by means of the hand lever shown. This lever is fitted with a silent ratchet connected to a rack and pinion, and gives the necessary leverage required for the weights handled. The length of the mortise is determined by adjustable stops. The traverse of the table to and from the chisel is by means of a hand wheel and a large square-threaded screw. The adjustable fence is fitted with a powerful screw cramp, and the lower end of the screw is anchored in a slot in the table, so as to form a vice to hold the timber. The countershaft and loose pulley are mounted on ball bearings and the belt shifter control is conveniently placed for the attendant.

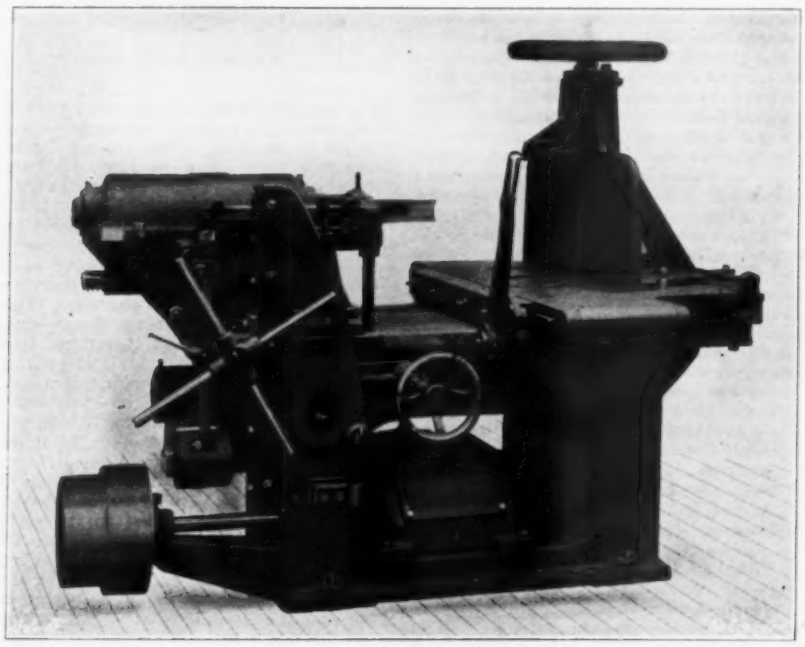


FIG. 3—WOOD MORTISING MACHINE

The machine will take timber up to 16in. deep by 14in. wide, and carries chisels up to 2¼in. square to mortise 5in. or 6in. deep. The maximum stroke of the chisel is 8¼in., and the vertical adjustment 14in. The table dimensions are :—Length, 48in.; width, 25in., with a longitudinal adjustment of 20in. and traverse towards the chisel of 8in. The fence adjustment is 8in., and the power required for operating the machine is 15 brake horse-power.

A spacing apparatus can be provided for repetition work.

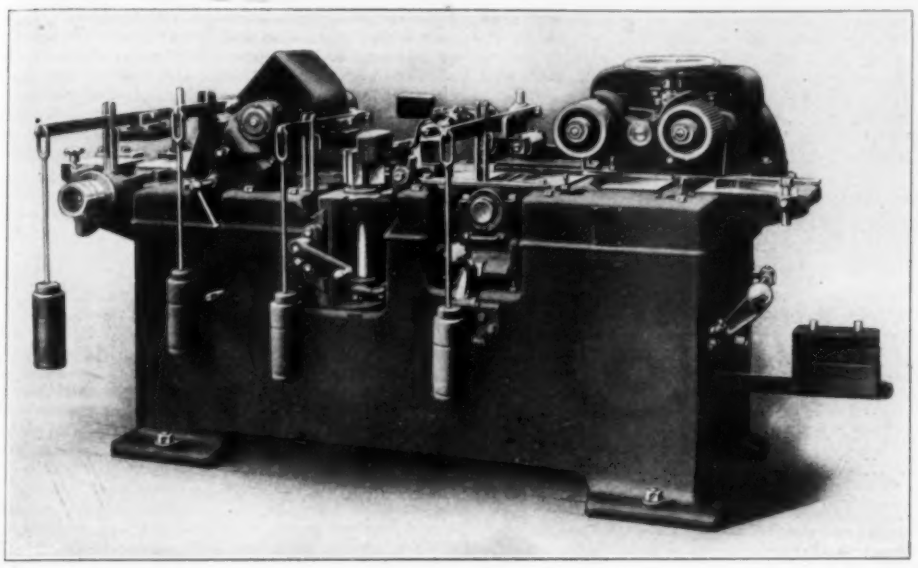


FIG. 4—WOOD MOULDING MACHINE

It consists of a stop carried from the middle slide of the table. This stop is arranged to turn over, and can be adjusted in width by means of a right and left hand screw to correspond with the size of the chisel in use. It operates in notches in a wooden template, which is cramped under the work. The notches are cut to the same length and spaces as the mortises required, and one or both ends of the template carries a cleat for location purposes. The template therefore travels with the timber, whether moved with the table or by hand, and always retains its correct setting relative to the work.

The moulding machine shown in Fig. 4 is specially suitable for general saw mill use, and particular attention has been given to ease and facility for setting up. All the cutter spindles are mounted in heavy double-row ball bearings enclosed in dust-proof housings, and the cutter blocks are of square section, lipped on all four sides to support the knives near to their cutting edges. The blocks are slotted for ⅝in. tee-headed bolts. A special feature of the machine is the ease with which the bottom cutter head can be withdrawn from the machine for access to the cutters. This is effected by means of a quick-acting screw cramp. Provision is also made for the head to be raised and lowered and tilted slightly for levelling to suit the timber. The gap in the table over the cutter block can be adjusted to suit various cutting diameters, and the table in front of the bottom block has vertical adjustment for adjusting the depth of cut. A double roller, or, alternatively, a pad "pressure" weighted by a lever carrying sectional weights, is provided. The vertical side cutter spindles are supported on ball bearing mountings, the lower bearings being of the full floating type, in which the inner race is carried in a steel sleeve held by the side head frame. The outer race is mounted inside the pulley, and as the shaft passes through the sleeve, but clear of it, it is relieved of the bending stress due to the pull of the belt. In this way the need for a bearing below the pulley is obviated, and the construction is simplified. The "pressure" in front of the left-hand side head is carried on an arm pivoted behind the head, and has a self-aligning wood pad which opens automatically ready for the following piece, should the timber run out. When moulding is being worked this pad can be easily removed and another substituted, which is shaped to the reverse outline of the mould. Pressure is applied by means of a weight carried by a chain running over side pulleys in such a manner that the position of the weight remains constant.

The top cutter head is fitted with a removable front bearing and block, which allows the block to be changed for profile heads or solid relieved mould cutters. The complete head, together with the front and rear "pressures" is designed to rise and fall by means of a crank handle and square-threaded screw, and it has a locking device to hold it securely in position. The front "pressure" is of the chip-breaking type, and is supported on levers carried by the cutter block frame. It can be turned over out of the way to give access to the cutters. This "preasure" has a wood pad inclined at a slight angle, and may be shaped to suit the mould which is being "worked." The rear "pressure" is of the lever type arranged to carry wood pads. An end bottom or feeding head can be added as a complete unit, and fits on facings at the rear of the table behind the top head. It has a removable bearing similar to that of the top head, and the table behind this head can be swung away to give access to the cutters. The tables are renewable and are held by clamps to avoid any holes or screw heads which collect chippings or mark the timber.

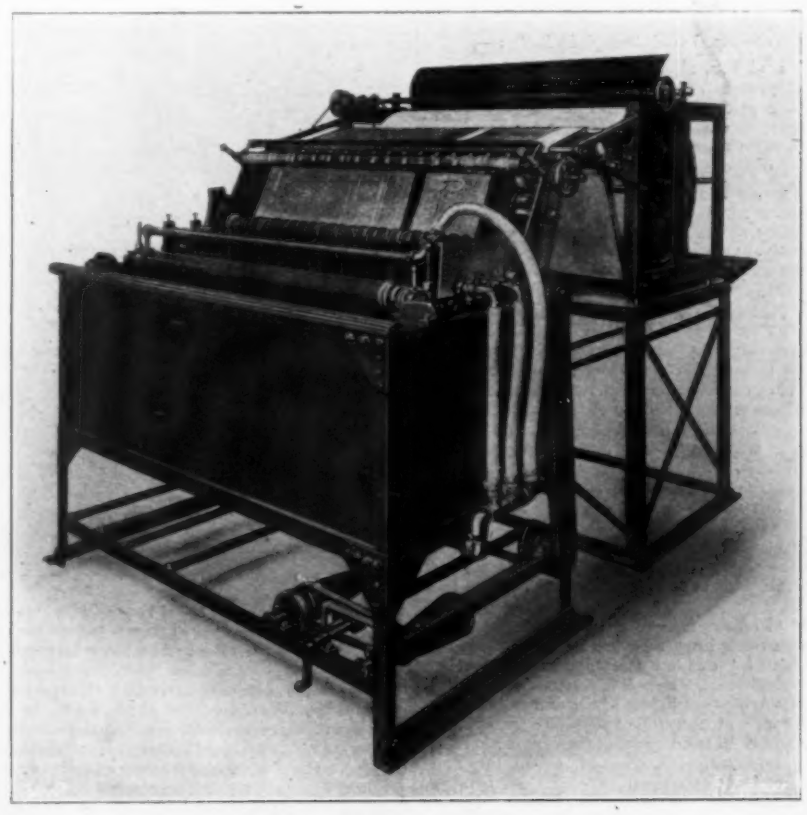
The feed gear consists of four rollers, 6in. diameter, all of which are driven by a train of enclosed machine-cut gears. The top pair of rolls are overhung, and may be easily changed for others to suit bevel sawn timber, and the first top and bottom rolls are fluted. The feed is controlled by means of a cone friction clutch mounted in a three-speed cone pulley, which gives rates of feed of 17ft., 36ft., and 50ft. per minute. Sectional weights, operating through levers, give the desired pressure on the top rollers.

Arrangements are made for exhausting the chippings from the cutter heads, and the bottom cutter head frame forms a hopper from which the exhaust may be easily "piped" away through a hole in the machine frame at the rear. Sheet steel hoods are provided for the side cutters to protect the operator, and can be detached in a few seconds. A particular feature of the machine is that it is entirely self-contained, no part projecting below the floor line.

The machine is designed to take timber either 6in. or 7in. wide and 3in. deep, and occupies 14ft. by 6ft. 6in. wide, inclusive of the countershaft, the power required to drive it being 12 brake horse-power.

A Blue Print Washing and Drying Machine.

In our issue of February 16th, 1923, we described and illustrated a machine made by Precision Photo Printing Plant, Limited, of 120, Moorgate, London, E.C. 2, for washing prints from tracings by passing them through a tank of water while they are between continuously running tape bands and a belt of wire mesh. We commented, at the time, on the excellent work turned out by the machine, but felt some doubt as to the wearing qualities of the wire mesh belt. We were consequently interested to find, on inspecting the original machine quite recently, that the same belt was still in service, and had been running for two years without trouble. The only alteration which had been made to the machine was a slight change in the water-circulating piping, which was designed to conserve the washing water. An addition had, however, been made in the form of a drying machine, which is shown in the background of the accompanying engraving.



BLUE PRINT WASHING AND DRYING MACHINE

This machine is really a very simple device, but it has taken a considerable amount of experimenting to get it to run entirely satisfactorily. One of the troubles which had to be overcome was the reduction in the areas of the prints in consequence of the shrinkage of the paper as it is dried.

The machine comprises a drum, 24in. in diameter, covered with felt and with a blanket round the lower part of its circumference. The blanket passes over guide rollers and is extended, after the fashion of a conveyor, towards the washing machine. The drum is heated by gas in the the case of the machine we inspected; but some of them have been arranged for electrically heating. That method of heating has the advantage that the heating and motor circuits can be so interconnected that the heating element must be switched off when the motor is stopped, and there is then no liability for the blanket to be scorched by carelessness on the part of the attendant.

The wet prints are delivered by the washing machine on to the projecting part of the blanket, and are carried round between it and the drum at a speed of from 8ft. to 10ft. per minute. They come out completely dry, and are guided off the drum by the bent plate which can be seen projecting at the top of the machine. The drum is driven by a chain from the same motor which works the washer, and scarcely half a horse-power is required for the combination. The little hand wheel seen on the right is connected with a free-wheel clutch in the drive, in such a manner that the drum can be pulled round quickly by hand if it is wished to hurry a print through.

As a test of the ability of the combination to handle flimsy paper, we tried it with a sheet of newsprint, and although that paper was so tender that it could hardly be picked up in one piece when soaked with water, the sheet came right through the washer and dryer intact, and was delivered from the dryer as crisp as it was when put into the washer.

SCHOLARSHIPS FOR APPRENTICES.—The following scholarships are offered annually for competition among the apprentices employed by Swan, Hunter and Wigham Richardson, Ltd., Barclay, Curle and Co., Ltd., and their associated companies:—One scholarship in Naval Architecture, open to the shipyard apprentices in the Tyne and Wear shipyards or repairing department of Swan, Hunter and Wigham Richardson, Ltd.; one scholarship in Naval Architecture, open to the shipyard apprentices in the shipyards or repairing departments of Barclay, Curle and Co., Ltd.; one scholarship in Marine Engineering, open to the engineering apprentices in the Tyne and Wear works of Swan, Hunter and Wigham Richardson, Ltd.; and one scholarship in Marine Engineering, open to the engineering apprentices in the works of Barclay, Curle and Co., Ltd. The object of these scholarships is to encourage self-improvement and the pursuit of scientific studies among apprentices in any department of the companies' works, thus helping the most deserving of them to obtain a university degree in naval architecture or marine engineering, and in general to raise the standard of knowledge in shipbuilding and marine engineering. The value of each scholarship is as follows:—The company pays (*a*) all university fees; (*b*) £55 towards the cost of necessary technical books, instruments, &c. The amount will be distributed in suitable sums during the tenure of the scholarship, *e.g.*, £20 to £25 in the first year and £10 to £15 in each of the subsequent years; and (*c*) a subsistence allowance of not less than £1 10s. a week, as may be deemed necessary, during the continuance of each university term.

Economics of the Heavy Iron and Steel Industry.*

By SIR FREDERICK MILLS, Bt., D.L., M. Inst. C.E., M.I. Mech. E.

I HAVE chosen for the subject of my address that of certain aspects of the economics of the heavy iron and steel industry, feeling that the conditions ruling here at present, as for some years past, call for investigation as to their cause, and some attempt to suggest lines of thought for your consideration.

The iron and steel industry of this country is one of the most important of all our industries. Richard Cobden called it "the Father of all the Industries"; working to capacity it gives direct employment to 300,000 persons, and indirectly in engineering and shipbuilding to 1,000,000. I at once ask this question—Are we entitled as a nation to continue in it, or must we let it go?

What has been, may well be again. Historically, we have a proud record; as in other countries, until the days of James Watt, who taught the world how to harness steam, our iron and steel production was not of great quantity, although of the very best in quality, but at the very beginning of what is known as the Industrial Era we at once sprang into the first place as producers of iron. So we continued until the adoption of Bessemer's invention by the United States, whereby in a very few years the colossal development of that great country began, and at the same time and by the same means—graciously acknowledged—they wiped off their national debt. In recent years they have outstripped us in point of tonnage, as indeed did Germany following the introduction of Bismarck's Tariff Laws in 1878. It seems to be a matter of reproach in the minds of some latter-day controversialists that Great Britain now takes third or even fourth place in her output of iron and steel; to me that signifies little; the real test surely is—is our industry progressing, is it prosperous (in the widest sense of that word), and is it adequate to the needs of the nation and of the Empire?

We cannot, I fear, say that we have progressed steadily or prosperously, for if you consult the statistics recently prepared by the National Federation of Iron and Steel Manufacturers you will find no marked progress, merely ups and downs. The pig iron output last year was 30 per cent. below that of 1913, and whilst the output of steel was approximately the same, there was imported no less a quantity of iron and steel than two and a-half million tons, which, had it been produced here, would have made a good showing; the total steel output would have been approximately eleven million tons, giving us second place among the nations; 100,000 more men would have had employment instead of being in receipt of the deadly "dole," and, in addition, the price of the home product would not have been regulated by the "give-away" prices of the foreign steel.

We at home are faced with two plain facts:—

(1) The cost has, since pre-war days, increased some 50/60 per cent.

(2) Selling prices have increased by only 30 to 40 per cent.; in consequence, the scant margin of pre-war profit has disappeared, and the industry has become unprofitable.

What can we do? But, first, what have we done? During the war much patchwork improvement was effected, mainly at the instance of the Government. I have recently had the opportunity of inspecting a large number of plants in this country where these improvements have been made, and being fairly familiar by personal experience with corresponding plants on the Continent and in the States I have no hesitation in saying that they are equal, if not superior, to them, and they reflect the greatest possible credit on the skill of our home engineers, and those directing them. Unfortunately, no co-ordination was attempted, nor could there have been; clearly the urge of the moment was the guiding factor. A great deal of the improvement was, however, of permanent value, notably the score of new blast-furnaces, projected and commenced, but none completed during the war; a great deal of open-hearth and rolling mill plant was completed, but unfortunately many of these schemes were left in the air by the Government in their natural and praiseworthy haste to bring war expenditure to a close.

This state of affairs is very unfortunate, especially as few British firms have now the funds available to complete their lay-out on the modern lines they intended.

For twenty-five years before the war we here were subject to a constant invasion of surplus iron and steel from any country in need of an outlet for it; in some years that importation amounted to as much as 25 per cent. of the home product, and I need hardly tell my audience that the price of so large an import naturally regulated the prices of the corresponding home product—in fact, it is well known that the margin of profit was so meegre that such improvement in plant as was made before the war required prolonged deliberation, and in all cases the necessary funds were grudgingly provided. Admittedly our industry was not at its best when the sudden catastrophe of 1914 called upon it to provide the sinews of war for two great nations; it is not surprising that we were unable to meet the strain, and consequently some portion of our task was undertaken by our cousins across the Atlantic, to whom we, as a nation, owe our cordial thanks.

No responsible Government nor body of public opinion dare advocate running a similar risk in future; already serious alarm is being felt both by the Government and by the public, and presumably "something will be done"—what that something should be is of a character quite unsuitable for discussion here; clearly the particular competition to which the iron and steel industries are here subject at the present time, and have been for many years past, is in many respects unfair, as Sir William Larke in his evidence to the Balfour Committee has testified. It may require special legislation for a few years, but whatever Governmental action be taken it is obvious that those who control the industry must be prepared to co-operate and to show that they know how the industry can be made efficient and adequate.

Has our hand lost its cunning? I venture to think it has not. When you contemplate the development that has taken place in the last ten years in the matter of fuel economy, the utilisation of by-products—until the production of steel has itself almost become a by-product of coal; the improvement in quality, of the methods of physical testing and of chemical determination, of engineering design and construction, you must feel reassured that we still have in our midst first-class brains.

On the other hand, unfortunately, we have to deplore the fact that our costs in regard to two items—coal and labour—have increased enormously and are altogether too high; coal and labour are almost identical terms, and I desire to draw your attention to them.

The price of metallurgical coal has advanced some 80 per cent. since pre-war days; for that calamity the metallurgical community, as such, is not responsible; but had we not in pre-war days set about the subject of fuel economy and continued in it since, iron and steel making on a large scale in this country might well have already become a thing of the past. It is not our province to produce cheaper coal, but it is competent for us to call for cheaper coal if the British iron and steel industry, and those others dependent upon it, are to live.

The other outstanding item of cost is that of labour—and here again steel and labour are almost identical terms—and at the outset I want to make it clear there can be no quarrel with the average earnings of the men employed in the iron and steel trades, although the disparity in earnings of the highest and lowest seems to call for adjustment. Further, I wish to pay a tribute to both sides of the Wages Regulation Boards which have clearly the best record for forty years, in the matter of avoiding strikes and lock-outs, of all the greater industries in the country. It is not that I am calling your attention to earnings, but rather to the cost per ton for labour.

What, then, is wrong? I am of opinion that the subject of labour has not had that amount of consideration and understanding that is necessary. How many men in the street would at once agree that the percentage of "ultimate" labour in the cost of a ton of steel amounts to at least 92½ per cent.? Very few. Most of them would guess about 50 per cent.; indeed, one constantly reads the expression of publicists, both parliamentary and otherwise, who put it no higher.

I have been interested in this subject for many years. A few years ago, with the assistance of Mr. Thomas, the head of the Cost Department at Ebbw Vale, we worked it out "in real herrings," as Sir James Barrie would say; we started with a ton of coal—where we not unnaturally found the ultimate labour cost is quite

TABLE I.—*Statement showing Allocation of Labour as a Percentage of Through Coal Cost of Production.*

	Total cost (as a percentage)	Labour Proportion. Direct. Percentage.	Direct. Labour cost.	Other British. Percentage.	Other British. Labour cost.	Foreign. Percentage.	Foreign. Labour cost.	Total. Percentage.	Total. Labour cost.
	Per cent.		Per cent.		Per cent.		Per cent.		Per cent.
Wages	58.16	100	58.16	—	—	—	—	100	58.16
Royalty	3.08	—	—	30	0.92	—	—	30	0.92
Electricity	5.11	45½	2.30	10	0.51	3	0.15	58½	2.96
Fuel	2.32	80	1.86	12	0.28	6	0.14	98	2.28
Pitwood	8.22	—	—	—	—	80	6.57	80	6.57
Castings	0.53	60	0.32	20	0.11	8	0.04	88	0.47
Bricks	0.13	81	0.11	12	0.02	3	—	96	0.13
Stores	5.05	—	—	75	3.79	—	—	75	3.79
Stone dust	0.19	60	0.12	—	—	—	—	60	0.12
Betterment fund	0.49	100	0.49	—	—	—	—	100	0.49
Engineering labour	0.04	100	0.04	—	—	—	—	100	0.04
Engineering material	0.08	50	0.04	40	0.03	—	—	90	0.07
Building stone	0.02	74	0.02	18	—	—	—	92	0.02
Pumping	0.05	86	0.04	8	—	—	—	94	0.04
Colliers' train	0.38	—	—	85	0.32	—	—	85	0.32
Workmen's compensation	2.11	100	2.11	—	—	—	—	100	2.11
National insurance—Health	0.50	100	0.50	—	—	—	—	100	0.50
National Insurance—Unemployment	1.00	100	1.00	—	—	—	—	100	1.00
Traffic	0.29	83	0.24	12	0.03	—	—	95	0.27
Wagons	0.02	60	0.01	30	—	—	—	90	0.01
Incidentals	6.28	45	2.83	26	1.63	—	—	71	4.46
Rates	2.01	—	—	90	1.81	—	—	90	1.81
Stables	2.07	20	0.41	65	1.34	—	—	85	1.75
Printing and stationery	0.06	50	0.03	40	0.02	—	—	90	0.05
Subsidence	0.21	—	—	95	0.20	—	—	95	0.20
House coal	1.60	100	1.60	—	—	—	—	100	1.60
Total	100.00		72.23		11.01		6.90		90.14

TABLE II.—*Statement showing Estimated Proportion of Labour as a Percentage of the Cost of Finished Sheet Bars.*

	Local.	Other British.	Foreign.	Total.
	Per cent.	Per cent.	Per cent.	Per cent.
Coal getting: Labour percentage of through cost	72.23	11.01	6.90	90.14
	Per cent. Per cent. Per cent.	Per cent. Per cent. Per cent.	Per cent. Per cent. Per cent.	Per cent.
Dry small transfer price	72.23 of 8.18 5.91	11.01 of 8.18 0.90	6.90 of 8.18 0.57	7.38
	cwt. Per cent. Per cent.	cwt. Per cent. Per cent.	cwt. Per cent. Per cent.	Per cent.
DRY SMALL consumed at washery	24.94 at 5.91 7.37	24.94 at 0.90 1.12	24.94 at 0.57 0.71	9.20
Add labour at washery (direct and indirect)	1.02	0.23	0.01	1.26
Total to coal washing	8.39	1.35	0.72	10.46
WASHED SMALL consumed at ovens	26.59 at 8.39 11.15	26.59 at 1.35 1.79	26.59 at 0.72 0.96	13.90
Add labour at ovens (direct and indirect)	1.88	0.54	0.01	2.43
Total to coke	13.03	2.33	0.97	16.33
COKE CONSUMED IN HEMATITE PIG IRON MANUFACTURE	20.80 at 13.03 13.55	20.80 at 2.33 2.42	20.80 at 0.97 1.01	16.98
Limestone consumed in hematite pig iron manufacture	10.76 at 2.33 1.25	10.76 at 0.62 0.33	10.76 at	1.58
FOREIGN ORE: Proportion of labour deduced from our own ore mine cost 84 per cent.			39.84 at 12.64 25.19	25.19
Add labour at blast-furnaces (direct and indirect)	6.65	1.47	0.07	8.19
Total to pig iron	21.45	4.22	26.27	51.94
PIG IRON CONSUMED IN THE MANUFACTURE OF BESSEMER INGOTS	22.84 at 21.45 24.50	22.84 at 4.22 4.82	22.84 at 26.27 30.00	59.32
Add labour at Bessemer shop (direct and indirect)	8.91	1.83	1.73	12.47
Total to Bessemer ingots	33.41	6.65	31.73	71.79
INGOTS USED IN THE MANUFACTURE OF SHEET BARS	22.29 at 33.41 37.24	22.29 at 6.65 7.41	22.29 at 31.73 35.36	80.01
Add labour at finishing mill and bank (direct and indirect)	10.18	1.59	0.46	12.23
Total to finished sheet bars	47.42	9.00	35.82	92.24
TOTAL COST OF FINISHED SHEET BARS PER TON				100.00

* Iron and Steel Institute. Presidential Address, May 7th, 1925.

90 per cent.—obviously here, the great bulk of the cost must consist of labour, and then we worked out every item of every stage of conversion to the final ton of steel.

It is an interesting study, but I do not wish to burden you with figures, but let us consider the *rationale* of the subject; the coal, iron ore, and the limestone are lying in the earth as a Benevolent Creation left them; how do they get themselves into a ton of steel? First, let us take the case of coal; the details, which are typical of any cost, are given in Table I.; there you will find, worked out in percentages, every detail of an exact cost at a particular group of collieries some moths ago; the direct labour is over 50 per cent.—the 50 per cent. of the theoretical economist of whom I spoke—but I shall have no difficulty in bringing practical men to the view that direct labour by no means exhausts the tale; no fewer than six other items of the cost are 100 per cent. labour, the remainder have been ascertained by reference to the actual pay sheets. See Table II.

Royalty is rent, from which there is no escape, even if royalties be transferred from the individual to the State, with or without compensation. I am not concerned to discuss the problem here; my inquiry is as to the causes of increased cost, and as the charge for royalty on coal has increased only since pre-war days by the gradual change from old leases to newer ones—that is to say, from 6d. to 6½d. a ton over the United Kingdom—the item has little effect; it is curious, perhaps, to observe that this much-discussed but little understood charge contains by actual ascertainment 30 per cent. labour.

I say the discovery of the exact ultimate percentage of labour is an interesting study. I find all the commodities I have examined contain from 90 to 95 per cent. labour cost, and I am accordingly inclined to the belief that all commodities are alike in this respect, such dissimilar things as a ship, a postage stamp, a railway rate, a book, a loaf of bread, a telephone call, a house, 1000ft. of gas, a newspaper, and so on. It is quite conceivable others in other industries have already made the same discovery; to me it is a recent one, and only by accepting it can I square cause and effect.

If the labour cost is over 90 per cent., of what does the balance consist? We have investigated that, and find that if everything required to make a ton of steel were concentrated under the same control and no profit be charged until after the total and final cost be ascertained, then the balance is once more nearly all ultimately labour; indeed, our inquiry leads us to suppose that the 92½ per cent. arrived at is limited only to that figure by fear of a charge of overstatement, and where no profit on stores, outside service, and the like is involved the real labour cost is nearer 97½ per cent.

The inference therefore is that it pays any community to employ its population to the fullest extent, because it thereby becomes a full-time consumer at the same moment it is a full-time producer.

Let me repeat, the coal and the iron ore lie as Nature left them in the ground and have cost man nothing; man digs them up, and burns the first to smelt the second; he manipulates the crude substance into the required final product—all labour up to a point, and that point lies between 90 and 97½ per cent.

Then what? If on examination for yourselves you confirm and accept my estimate that a ton of steel consists of over 90 per cent. labour, you will appreciate that if we are to improve our costs we must so order our affairs both public and private that we can get a better output for the labour now employed, because you will remember that I do not complain of the average earnings, but of the cost of labour per ton. If we can do this, if we can get more tons, we can get them cheaper, we can sell more tons and therefore increase employment.

I stress the view that a ton of steel consists of 90 to 95 per cent. labour, because I want works managers to cease to regard a ton of steel as a ton of steel, and to regard it rather as nine-tenths of a ton of labour. Put it another way—if that 5-ton ingot on its casting car could have been made with half the number of men, or if two 5-ton ingots could have been produced by the same number of men, they would have cost approximately half as much. It can be done, and there would be no hardship to anyone, only benefit and increased employment, because we could make more tons and sell more tons in competition with the world, and thereby employ more men.

The leaders of our men must tackle the subject from this point of view, and co-operate with the managers; every furnace, every machine, must be allowed to work to full capacity, and until they can persuade their continental brethren to come up to our conditions they must approximate our hours of work and wages to theirs, or produce proportionately more per unit of labour, if our industry is to live. Some of the fancy earnings, such as the £20 to £25 a week—clearly unearned increment—paid to the thirty first-hand melters in a ten-furnace shop must be amended if the product has to be sold against the product of a similar shop abroad where the corresponding wage is £2 to £3 a week.

Let me return to coal. It is admittedly the foundation of our industry. The cost for coal per ton of steel varies as to the iron contents of the ore from which steel is made; in Great Britain it varies from one-fourth to one-half of the total cost of the steel made. We see, therefore, how important it is that the industry should be provided with coal at a lower price than at present.

It is not the metallurgist's job; we can only call for it. I will content myself by saying if it is not forthcoming at a price comparable with the price in Europe or the States, England must cease, for a time at least, to expect to support a manufacturing population. I decline, however, to think that the call will not be answered—it is too obvious that it must be.

On our part there is still much room for improvement in our use of coal; great strides have from necessity been made in recent years, but the subject of fuel economy in our ironworks, and particularly in our steel works, will afford further scope for study and research. It is not inconceivable that the coke ovens should be the only consumer of all the coal required to make a ton of steel.

Are we quite sure we were correct in our policy of rejecting, for the most part, the use of large gas engines using coke oven and blast-furnace gases, the discovery of B. H. Thwaite, and first employed at Wishaw in 1896? The process is nearly universal on the Continent; there are works there making 40,000 to 50,000 tons of steel a month which have no other source of power, except for emergency, and I am convinced this subject deserves further consideration. Something has been done by some firms. I saw recently one works where gas engines are largely employed, and others where they are partially employed, but in most of our establishments they are entirely absent.

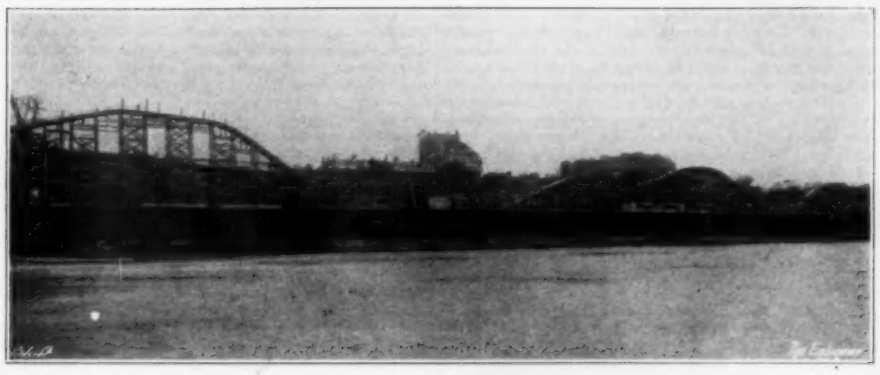
There are plants in this country where the coke ovens and blast-furnaces are excellent, and where the cost of conversion from coal to pig iron is second to none, but in those cases the benefit is lost in the subsequent processes. There are plants where the reverse is equally true. It will be in the best interests of the industry if means can be found to reconstruct a number of the plants in agreed areas and bring them as near perfection as possible.

It will be of still further benefit if our proprietors can amalgamate their interests, and arrange for the segregation of orders and concentrate them into those areas and those works most suitable for their production; our present practice—the survival of former years—whereby a great variety of shapes is rolled in the same works is wasteful; specialisation is the order of the day—we must adopt it.

Can we not go even further? Is it beyond the wit of those who control our hundred and one iron and steel works to devise means for the physical amalgamation of those plants which are geographically suited for the purpose? The public may be afraid of a trust—they need not be; there are real trusts all around them, unobservable, or at least unremarked. But apart from that, should such grouping result in greater efficiency, I venture to suggest grouping, combined with prosperity and progress, is of greater use to a country than insane competition and stagnation.

SWITCHBACK RAILWAY AT THE PARIS EXHIBITION

SIR WILLIAM ARROL AND CO. (SWANSEA), LIMITED, ENGINEERS



UNDERSIDE OF THE SWITCHBACK

A Switchback at the Paris Exhibition.

A SWITCHBACK railway of unusual size, and considerable engineering interest, has just been completed and put to work at the Exhibition of Decorative Arts, now being held in Paris, by Sir William Arrol and Co. (Swansea), Ltd. It consists of a double railway line running along the Quai d'Orsay, on the bank of the Seine, from the Pont-des-Invalides, a distance of over 600 yards. The return journey is, therefore, over two-thirds of a mile in length. The greatest height of the track above the foundation level is approximately 70ft. The track is supported by a timber framework, of varying height, which is erected on the tops of a series of lattice work steel trestles tied together, transversely to the track, by lattice girders, and, longitudinally, by a number of runner angles and deck joists. By adopting this arrangement the rapid manufacture of the steel work was made possible, as only seventeen different combinations of steel trestles—the greater number of which could be subdivided into three or four main component parts—were employed. In passing, we may say that rapidity of delivery was an important factor in the placing of the order, which was given to Messrs. Arrol because they could guarantee completion in only six weeks.

The contract for the steel work included the supply of a light bridge, 25ft. wide, and having a span of 60ft., to carry a double track over the Pont-des-Invalides, and a steel framed ramp leading from the ground level to the starting point of the railway.

The following summary of some of the leading dimensions is of interest:—

Height of main trestles	17ft.
Longitudinal centres of trestles	12ft.
Transverse centres of trestles	56ft. 6in.
Length of main griders..	67ft. 6in

The total weight of the steel work, comprising 154 double trestle frames, the bridge ramp, deck joists, &c., was 616 tons, and the number of holes which had to be drilled was approximately three hundred and fifty thousand. The accompanying engravings show the completed structure, and an underneath view in which the details of construction will be seen.

A Self-Synchronising Alternator.

THE troubles that were experienced in connection with the parallel operation of alternators in the early days of electricity supply gave rise to a great deal of thought and investigation, and there were sometimes arguments between the engine and alternator builders concerning the question of whether the troubles arose from mechanical or electrical causes. The requirements for good parallel operation were at one time very imperfectly understood, but, thanks to the investigations of Dr. Rosenberg and others, engineers now know a great deal more about the matter than they did in the past. The cyclic irregularity of the prime movers installed in generating stations some twenty years ago often made parallel operation very difficult, and on some occasions stations were completely shut down as a result of "hunting" or phase-swinging. But in these days of turbo-generators, with a small number of poles and with the even turning moment of the turbine, parallel working is a relatively simple matter, although difficulties still sometimes arise when a new turbo-generator is required to run in parallel with slow-speed reciprocating engine sets. The parallel operation of gas engine-driven alternators was regarded in the past as a very difficult matter indeed, and although with proper precautions troubles can now be avoided if suitable engines are installed, cases are sometimes met with which demand special treatment.

To enable alternators to run in parallel under the most adverse conditions and even when gas engines with very light fly-wheels are used, Mr. L. J. Hunt, of 4, Broad-street-place, has designed a new machine, which is shown in Figs. 1 and 2. The alternator may be connected to the bus-bars without synchronising, and it will continue to run satisfactorily, even if old gas engines, with an irregular turning moment, are used. Engines that have been employed for driving direct-current machines can, if it is necessary to change over to alternating-current generation, be coupled to these new alternators, which may be run in parallel. The fact that the alternators can be connected to the bus-bars without synchronising is, of course, a matter of some significance in the absence of skilled attendants, but the adoption of self-synchronising machines is not a new idea, and some electrical firms, we presume, can now supply such machines if called upon to do so. Many rotary converters and synchronous motors that are in use to-day pull into step on their own accord, and we do not think that engineers connected with small generating plants would find great difficulty in obtaining self-synchronising generators, if they require them. But the self-synchronising property of Mr. Hunt's alternator is not its principal advantage. What the inventor mainly claims is that his machine will run in parallel with other alternators under very adverse conditions, and that the prime movers need not conform with the usual requirements. It is said that these new alternators are suited for use on Diesel-electric ships, and that there are various other conditions under which they may be employed with advantage. At one time the asynchronous or induction generator appeared to have a field of application, and years ago it was proposed to install some of these alternators at Birmingham, but it was soon recognised that they were unsuitable, owing largely to the fact that the magnetising current is drawn from the line.

Some alternators designed in accordance with Mr. Hunt's scheme have been built to the specifications of Mr. H. D. Wilkinson, consulting engineer, for supplying power to the Leckhampton Quarries, where we were recently afforded an opportunity of seeing them tested. Each machine, which is fitted with a direct-coupled exciter, is rated at 160 kilowatts at a power factor of .8, power being supplied to the quarries in the form of three-phase 50-cycle 440-volt current. The engines, which run at a speed of 250 revolutions per minute, were supplied by the Premier Gas Engine Company, Ltd., and are of the four-cylinder horizontal type.

The new alternator resembles in appearance an ordinary induction motor. The stator carries the resultant field of sixteen and eight poles, and it has open slots, whilst the rotor slots are partially closed. There are 144 slots on the stator, and in these slots two windings are placed—a winding (as shown on the left of Fig. 3), which carries both 50-cycle and direct current, and another winding, which only carries the exciting current, as indicated on the right of the diagram. The rotor slots carry a simple short-circuited winding, producing the same effect as two independent sixteen and eight-pole windings, there being 192 slots, in 96 of which there are two bars, and in the remaining slots one bar.

It will be perceived that the stator winding from which the alternating current is drawn at the points M_1, M_2 and M_3—see Figs. 3 and 4—are formed by two parallel connected star windings, and the exciting current flows through this winding by way of the neutral points. As in each pair of paralleled branches of the winding the exciting current flows in the same direction as the alternating current in one star-connected winding, and in the opposite direction in the other, it only produces eight poles, whereas the alternating current produces sixteen poles. As indicated on the right of the diagram, Fig. 3, the other part of the stator winding only carries exciting winding and all the winding units are connected in series with the exciter. By arranging the windings in four similar units and by placing similarly situated wires of each unit in the same slot, it is unnecessary to insulate the sections from one another, as there is no difference of potential between them. This not only simplifies the construction, but by the use of these winding units the required paths are provided for the flow of the induced currents, which give rise to successful parallel operation, the stator winding being so arranged that when the speed no longer corresponds with the synchronous value, the currents which are induced in it produce a magnetising effect, and the restoring torque is developed by the rotor current. Tests have shown that if a stator winding is employed, which permits the induced currents to flow mainly across the centre of the eight-pole field, and therefore to provide a large restoring torque, the machine is no longer self-paralleling.

The principle on which the alternator operates is not difficult to understand. In effect, it acts partly as an asynchronous or induction generator and partly as a synchronous machine, the latter part of the combination supplying power and magnetising current to the non-synchronous part. The arrangement enables the machines to be put in parallel with other alternators without synchronising, and allows them to run satisfactorily under very adverse conditions. In fact, Mr. Hunt claims that his machines will work under conditions which would render the parallel working of ordinary alternators impossible. Machines such as those at the Leckhampton Quarries, where the periodicity is 50 cycles and the speed 250 revolutions per minute, have eight poles on the synchronous element and sixteen poles on the non-synchronous element, making twenty-four poles in all. Perhaps the simplest way to consider the action of the machine is to regard it as two separate machines arranged in a similar manner to a La Cour converter, without a commutator, and with eight poles on the synchronous element and sixteen poles on the induction element. With the rotors mechanically and electrically coupled and with the eight-pole stator winding connected to the exciter and the sixteen-pole winding to the alternating-current bus-bars, at a speed of 250 revolutions per minute, currents will be generated in the eight-pole rotor winding having a frequency of

$$\frac{4 \times 250}{60} = 16\tfrac{2}{3} \text{ cycles per second.}$$

These currents will flow in the rotor winding of the sixteen-pole machine, and will produce in them a rotating field which will revolve round the rotor itself at a speed of

$$\frac{16\tfrac{2}{3} \times 60}{8} = 125 \text{ revolutions per minute.}$$

But as the rotor is running at 250 revolutions per minute, the field rotates in space at a speed of $250 + 125 = 375$ revolutions per minute, and the field therefore generates current in the sixteen-pole stator winding having a frequenty of

$$\frac{375 \times 8}{60} = 50 \text{ cycles per second.}$$

The eight-pole synchronous machine supplies to the rotor of the induction generator currents which lead on the electromotive force generated in the stator windings, and so provides the magnetising current required to excite the sixteen-pole field, and that required by the external load. The machines at Leckhampton will run in parallel when the gas supply to two cylinders is cut off, but as the engines cannot be operated with a single cylinder, it has not been possible to make a test under the latter conditions. A 210 kVA alternator of the new type and directly driven by a four-cylinder hot-bulb engine is, however,

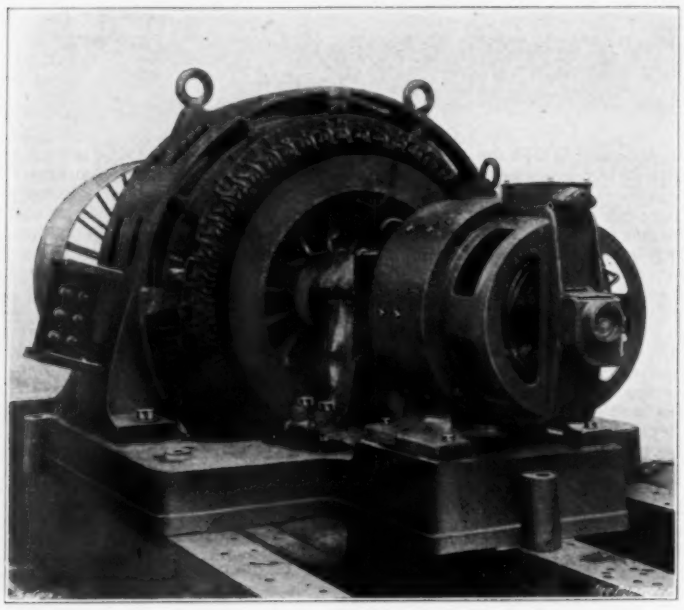


FIG. 1—SELF-SYNCHRONISING ALTERNATOR

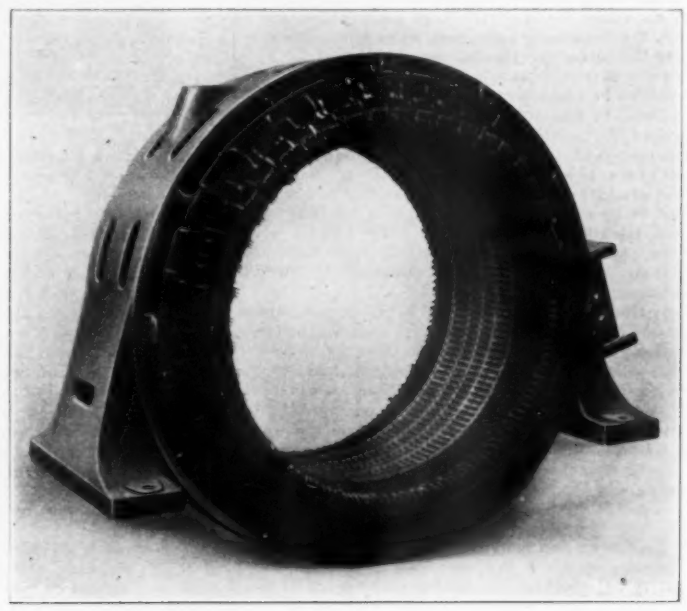


FIG. 2—STATOR OF SELF-SYNCHRONISING ALTERNATOR

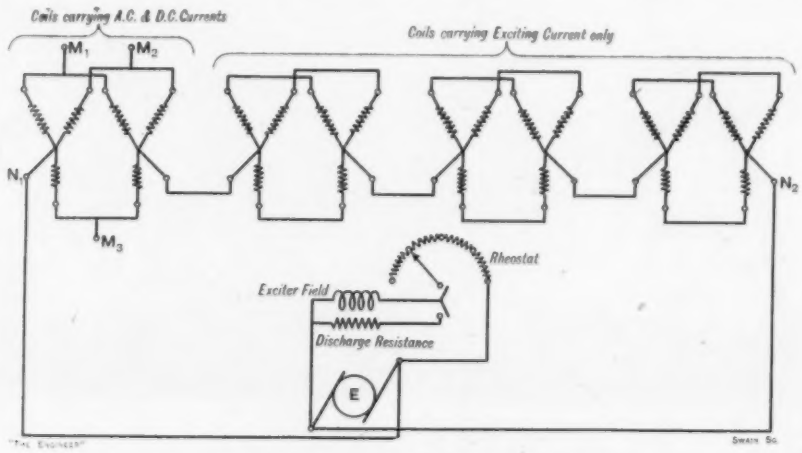


FIG. 3—ARRANGEMENT OF STATOR WINDINGS

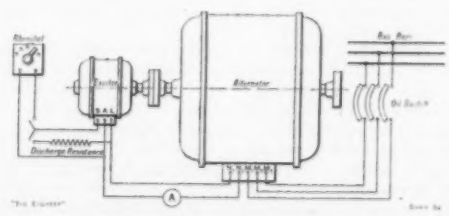


FIG. 4—EXTERNAL CONNECTIONS

being run in parallel with an ordinary alternator, driven by a Bates single-cylinder engine at the British Steel Piling Company's works, Gaydon, near Ipswich, the alternator having been designed to the specification of the consulting engineer, Mr. W. S. Verrill, of Newcastle-on-Tyne.

During our visit to the Leckhampton Quarries, eight tests on the two four-cylinder gas engine-driven alternators were made. In the first case the machines were paralleled with all four cylinders of each engine at work. The engines were then made to work with four and three cylinders respectively, when the alternators were again paralleled. Another cylinder on one of the engines was then put out of action, and the alternators were paralleled with a four and two-cylinder engine at work. In the next test the alternators were paralleled with each engine working with three cylinders and afterwards with three and two cylinders. After another paralleling test with each engine working with two cylinders the alternators were paralleled whilst the synchroscope indicated opposition of phase, and, finally, the second alternator was put into parallel with the first machine when running 4 per cent. below speed. In every case the alternators pulled into step with very little difficulty, thus indicating that the object which Mr. Hunt has aimed at has been achieved. We should imagine that the inherent regulation of alternators of this type is not so good as that of ordinary machines, but as automatic regulators are now very widely used in many instances that is not a matter of great importance. The machines were built by the Sandycroft Company.

Mr. W. H. Wilkinson, the consulting engineer to the Leckhampton Quarries Company, Ltd., has kindly sent us full particulars of the whole job, but for the present it must suffice to say that the generating plant was guaranteed to work with a full-load consumption not exceeding 1.35 lb. of anthracite, having a calorific value of 14,500 B.Th.U. per electrical unit. At three-quarter load the guaranteed consumption was 1.65 lb., and at half load 2.2 lb. On a full day's test run with fuel having a calorific value of 14,670 B.Th.U. per pound, the consumption per kilowatt-hour at 92 per cent. of full load and .98 power factor was 1.27 lb. per kilowatt-hour; at three-quarter load 1.45 lb., and 1.53 lb. at half-load, as against the guaranteed figures corrected for calorific value of 1.33 lb., 1.63 lb., and 2.17 lb. respectively. These figures, which were obtained after deducting 6.6 kilowatts, which is the power used for engine cooling, prove that the plant has a high efficiency in respect of each of the three generating stages, viz., gas producers, engines and generators.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Brighter Market Tone.

THE weekly meeting of the Midland iron trade in Birmingham to-day—Thursday—was better attended than several of its recent predecessors, and the tone was a little less inert. A few encouraging inquiries have come to hand, and they have resulted, in a few cases, in forward buying, covering the next few months, an unusual experience for some time past. General demand alike for iron and steel remains very small, and in many departments there is keen competition for any orders which come on to the market. Nominally values remain unchanged. Manufacturers in this area hail the Budget announcements with more or less satisfaction, and it is agreed that industry will be benefited. The heavy trades, which have been under a cloud for so long, will not derive direct benefit in the same way as the motor car industry, but, nevertheless, the considered opinion is that it is a step in the right direction, and, at the worst, the reduction of income tax is a crumb of comfort.

Finished Steel.

Competition remains particularly acute in the steel industry in the Midlands, especially in ship and tank plates, in which there is now a free market. The demand for constructional steel has been stimulated a little by the recent reduction following the abolition of price control. Anything like a slump in prices, however, is considered out of the question, selling rates having been already almost at the lowest limit, profits being very difficult to make. The small requirements of the district in the matter of structural plates are being competed for on the basis of £9 10s. Constructional engineers are pressing for plates at £9 5s., and it is just possible that this figure, for a good tonnage, might be accepted. Generally speaking, however, sellers hold out for £9 10s. Stocks are getting rather low in builders' hands, and an agreement as to prices between buyer and seller would probably be followed by business. The steel trade has benefited a little by the fall in pig iron values, and the very low prices at which steel scrap can be bought, £3 being a common price for this district and £3 12s. 6d. for South Wales. Scrap is now an important element in steel production, but the parlous position is indicated by the numerous refusals to take scrap deliveries on old contracts. There is some decline in the demand for wire rods. For all-English makes £10 10s. is quoted, and for rods rolled from continental billets £9 10s. Wide and thick sizes of steel tube strip can now be bought at £8 10s. upwards. The reductions in steel values still leave a rather wide opening for foreign competition. One concern which invariably quoted minimum prices is reported to have lost a large order to Germany for steel tube strip, accepted at about £7 against the home figure of £9. Much more substantial reductions will be necessary if Belgian joists, bars, sections, &c., are to be met in competition. The Budget concessions are somewhat favourably regarded, but steel makers ask more substantial assistance to meet the combination of exceptional circumstances against which they now have to contend.

Billets.

There is more activity this week in Belgian billets, which can be bought at £6 5s. delivered in this district. Welsh mills are making a bid for a larger share of the business passing. One large firm has taken the lead in accepting £6 15s. for mild steel billets. The bulk of the works require £6 17s. 6d., but it is anticipated in many quarters that the price will stabilise at the lower figure. This is 10s. above the Belgian quotation, a difference insufficient to give the foreigner a practical advantage when quality, foreign cash terms, and quick delivery are taken into consideration. The foreigners usually require five to six weeks to place the steel in the works of the British user.

Finished Iron.

Business in the Staffordshire finished iron trade is practically unchanged, the only development being the receipt of some orders by mills the plant of which is employed in steel re-rolling. Producers of raw material at home, however, are not profiting much, the bulk of the steel re-rolled being of foreign origin. A good deal of continental material is entering the Black Country at prices most substantially below home makers' rates. In the nut and bolt trade the bulk of iron used is foreign, deliveries being given at £7 2s. 6d. to £7 5s. compared with £11 10s. to £11 15s. for Staffordshire iron of similar nature. Crown quality iron produced locally makes about £12 15s. Local ironworks still decline to follow the reduction of 7s. 6d. in Scotch malleable iron, but it is possible to get an attractive order accepted at £12 10s., though there are a few makers who still insist on the full £13 figure. It is reported that a number of orders have recently been obtained by local works solely on the special merits of Staffordshire wrought iron in comparison with steel, in spite of the much lower price of the latter. Such cases are, however, exceptional, the keen competition obliging many makers to take the cheaper material. Marked bar mills continue fairly employed at about two-thirds capacity, and the price of this product is unaltered at £15.

Galvanised Sheets.

Galvanised sheets have a steady sale, 24-gauge corrugateds commanding £16 10s. to £16 12s. 6d. per ton for export and £16 15s. for home consumption. Mills have fairly good order books, and are assured of employment for a few months ahead. Quietude prevails in the tin-plate trade, but values are firm.

Pig Iron.

Pig iron is in no better demand, and, generally speaking, last week's quotations obtain, though here and there business for prompt deliveries is reported to have been done at slightly lower rates. Apparently some houses are out to liquidate stocks, but, on the other hand, most firms are successfully resisting any further price depreciation. It is claimed that iron cannot be produced to sell at current rates at a profit, and business is on such meagre lines that many Midland smelters are doubtful as to their ability to keep the furnaces in blast much longer. Forge qualities continue a drug on the market, while the few orders given out for foundry sorts are for very small tonnages required for immediate needs.

Smelters and Coke Supplies.

The experiment of adjusting the prices of smelting coke on chemical analysis has not resulted in a general adoption of the sliding scale in the Midlands. Many owners of blast-furnaces who tried it have returned to the old practice of making the best bargain they can on the open market, relying on the supplier to deal faithfully by them without any express specification. There is, however, a group of associated furnaces where the principle of payment by results is still applied. By midsummer it will have been in operation a year, and notwithstanding the vicissitudes which have been encountered, those who originated it are unshaken in their faith as to its essential soundness in practice as well as in theory. More than once after the basis price has been fixed at the beginning of the quarter the market has receded, and smelters outside the arrangement have been able to buy below the scale rates. Such conditions have come about during the past month. No agreement was made for price stabilisation in the first quarter of 1925. Recently, however, the basis was fixed at 15s. 9d. for the second quarter. The grade of coke ordinarily used in Midland blast-furnaces would cost about 17s. under the scale. This figure has already been undercut on the open market by 2s. Repetitions of this experience put a strain on the loyalty of those blast-furnacemen who have made contracts under the scale. But it does not affect the merits of the scheme for varying the price according to the calorific value of the coke supplied.

The McKenna Duties.

The Coventry motor engineering industry received with the keenest satisfaction the Chancellor's announcement of the re-imposition of the McKenna motor car duties, and it is the general consensus of opinion that the position of the industry will be materially strengthened as a result. Coventry, which put up such a strenuous fight a little more than a year ago for the retention of the duty on foreign motor cars imported into this country, is naturally elated. The motor trade in the city at the present time is undoubtedly prosperous, and the season, which is now well advanced, has been a good one, but it is recognised that the position attained is largely due to the momentum which the industry gathered under the influence of the small protective duty prior to the action of the late Labour Government, and ever since the removal of the duty the need for the same effective stabilisation of the British motor industry has been all too apparent to those responsible for its conduct, and to all keen observers. The re-imposition of the duty will not, it is anticipated, have any immediate effect on the trade, in that it does not take effect until July 1st, when the present seasonal trade must be regarded as drawing to a conclusion; but it is held that the restoration of the duty will fill in the greatly required need of stabilising the position for next year's programme.

Cannock Chase Mining Forecast.

An important forecast of the probable future developments of the Cannock Chase coalfield in the direction of Brewood was made by Mr. A. I. James, general manager of the Littleton Collieries, in acknowledging his re-election as chairman of the Cannock Rural Council. Mr. James said he did not wish to pose as a prophet, but he believed that as the older collieries in the Cannock Chase district become unremunerative they would be replaced by new collieries which would be opened on the western and north-west side of Cannock Chase, that was to say, towards Four Ashes, Penkridge, Dunston and Acton, Bednall and probably also Brewood. The coal existed in those localities, but it lay at a great depth, and it would be very expensive to get.

Unemployment.

Following large increases in the numbers of unemployed in the Midlands, caused in the main, through the Easter holidays, there is now an improved condition, the present total of 134,487 being 7205 less than it was in the Ministry of Labour's return issued last week. Decreases were recorded at Birmingham, Coventry, Bilston, Cradley Heath, Derby, Dudley, Leamington and Warwick, Leicester, Nottingham, Oldbury, Peterborough, Smethwick, Stoke-on-Trent, Stourbridge, and Brierley Hill, Tipton, Walsall, West Bromwich, Wolverhampton, Wednesbury, and slight increases at Northampton, Redditch and Worcester.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

THERE has been very little change in the general position of trade here, and if anything actual business is scarcer than it was. The expectation that the disclosure of the Budget proposals would give a fillip to business, although somewhat freely entertained here, has been disappointed; and the only effect of the Budget so far has been a violent outburst of indignation in the textile trades. Indirectly, of course, any permanent injury to the textile industries would affect the prosperity of Manchester business in iron, steel and metals, but the present upheaval does not touch the matter. The relief from some forms of taxation is not considered sufficient to bring about any revival in business, and certainly there is no disposition yet to put up the prices. On the contrary, almost all consumers here are expecting lower prices in the near future, and are keeping back from buying to the greatest possible extent in the confident belief that the longer they delay the lower the prices they will have to pay. In these circumstances, of course, active business is impossible.

Metals.

The recent advance in copper prices has ended, as all these movements have done during the last four years. There is a sharp rise in the standard market, a belief amongst sanguine people that the long-expected revival has come, and then a relapse which makes the sceptical more sceptical than ever. This has occurred so many times that sober people, when they hear of a rise in copper, shrug their shoulders, and refuse utterly to be stampeded into buying. The copper manufacturers, however, hasten to put up the prices for sheets and bottoms, and thus the engineer suffers during every one of these ephemeral advances unless he is fortunate enough to be able to wait for a week or two after the raw market falls back again. There has been some talk lately as to the ultimate effect of the low prices on the output of copper; and, of course, it may be admitted that there are copper properties which require a better market than the present to make them good paying concerns; but on the other hand, the greater quantity of the copper in the world is produced at a cost very much below even the lowest conceivable selling price. Recently the producing costs of one of the large American companies were published, and they were under 4¼d. per lb. for refined copper. Other American costs are round about 3½d. per lb. There was some little improvement in the local demand for ingot copper while the market was rising, but it has now disappeared, and a dull time is reported. Dealers in scrap material are inclined to reduce their buying price a little, but there is not much change, because they did not advance the prices to any extent. In the market for tin the sharp reaction is taken as quite the ordinary thing. It has been very difficult, if not quite impossible, to form any reasonable view as to the course of the market. All the ordinary guides pointed to the probable maintenance of the recent advances; and although reports as to the "visible supply" and as to American consumption were good, the market suffered quite a serious setback. Lead and spelter have again been rather weaker, perhaps in sympathy with copper and tin. Lead, however, was no doubt due for a reaction, for the whole range of prices has been extravagant for a long time. Spelter has been weak, partly because of the lower prices for other metals; but mainly because the demand has been poor, and the galvanising trades do not show signs of activity.

Pig Iron.

The markets here for pig iron are very dull and quiet, and the fixed belief amongst consumers is that the prices have yet to come lower. Of course, sellers and makers combat this idea, and declare that any further fall in prices must lead to a diminution in the output. This is already low, but, according to all reports, iron is beginning to accumulate at the furnaces, and in these times any such development is very much disliked by the ironmasters. One furnace was put out recently in the Derbyshire district; but in another Midland district it is said that two others—idle for nearly a year—are to be put in blast, whether for foundry iron or for other kinds of pig iron is not known. The nominal price of Derbyshire No. 3 delivered in Manchester is now 83s. 6d. per ton, but one would not like to say that business could not be done at 82s. 6d. Many consumers here say that the price of this iron will soon be at 80s., which would mean 72s. 6d. on trucks, and as Northamptonshire No. 3 has been

selling for some time at 70s. on trucks, they argue that the Derbyshire price need not be more than 72s. 6d. In fact, it is clear that when Derbyshire competes in the Midland district with Northamptonshire it has to be sold at about that price, and there is no reason why the Manchester ironfounder should be at a disadvantage. Of course, this must be understood as the consumers' line of argument. Derbyshire makers can find plenty of reasons why their furnace price should be 5s. or 7s. 6d. per ton above that of their neighbours. Scotch iron is rather weaker here, but it is still far too dear to allow of any extended use in foundry practice generally. East Coast hematite iron can be bought here at nearly 10s. per ton less than the price of Scotch.

Steel.

The extreme dullness in the finished steel trade is unrelieved. There is very little new business going on here, and although the nominal prices have not been altered again, consumers seem to think that they have a right to a 5s. concession. Hence joists and angles are not easy to sell at £8 10s., and the idea of the buyer, when he wants any at all—and this is seldom—is £8 5s. per ton. Steel plates are quoted at £9 7s. 6d., but probably £9 5s. would be taken. Steel bars vary according to section from £9 to £10 per ton. The finished iron trade is very dull, and the recent concession of 10s. per ton does not seem to have made any difference. To preserve the trade here we want a concession of £3, or, in the alternative, a duty of £3 under the Safeguarding Act; but, of course, one offers no opinion as to whether the trade is worth saving at such a cost.

Scrap.

The dullness of the scrap market seems to be accentuated this week. Dealers cannot find a satisfactory market for steel melting scrap; and some of them now seem to be nervous about paying 55s. per ton for it. There is a small but rather intermittent demand for heavy wrought scrap at 80s. per ton. Cast scrap is held fairly steadily, but, with the sagging in pig iron, consumers naturally expect to buy it on easier terms. The supply, however, is not now too plentiful, and dealers are trying to reduce the difference between cast scrap and pig iron. Their theory is that if common pig iron is worth 83s. 6d. in Manchester, then broken machinery metal ought to be worth more, say, 85s. at least; but for several years the founders have been in the habit of getting the scrap at 5s. and sometimes at 10s. less than the pig iron.

BARROW-IN-FURNESS.

A Dull Market.

The hematite pig iron trade in the North-West district has developed further weakness, and the damping down of one or two furnaces cannot be long delayed. There is evidence in the district of the accumulation of stocks, and this increase in tonnage of unsold pig iron is opposed to present policy for many reasons. It may be that some makers are accumulating stocks in preparation for damping down for a period, during which customers would be supplied from those stocks. The Scotch trade has shrunk very considerably during the past few months, owing to the quietness in trade on the other side of the Border. The amount of business being done with the Midlands is also on a much smaller scale, the size of the orders being reduced. Business with Welsh customers is small, and much of it is being carried coastwise. The Continent provides few orders, and none of any size, while the American trade is spasmodic. The charcoal furnace at Backbarrow, the only one of its kind in this country, continues to work, and there is a moderate demand for the special iron smelted. There is not much business being done in special qualities of hematite pig iron.

Steel.

There is little difference in the steel trade. Orders are not plentiful by any means, and it is mostly hand to hand with most makers. The Barrow rail mills are still engaged, and the heavy mill at Workington for the rolling of steel sleepers has started for a run of a few weeks. The hoop and small section mills at Barrow are keeping fairly busy, and the Siemens and foundry departments are moderately employed.

Shipping.

Since the London, Midland and Scottish took over the Barrow docks from the Furness Railway Company there have been no developments; in fact, there is a desire on the part of some of the shipping lines to see the channel deepened to the extent of 5ft. Large steamers are likely to get "neaped" sometimes, and that means them lying out waiting for more water, which occasions considerable expense. Wireless saved a steamer from Australia last week from being hung up. The steamer was carrying 6000 tons of wheat, 3000 tons of which were for Barrow. Her orders were to call at Falmouth for orders. If she did, the delay would have resulted in her being "neaped." Wireless messages were sent out telling the captain to proceed with all dispatch to Barrow. They were received, and the vessel made the port just in time. If the channel were dredged deeper such a rush as that would not be necessary.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Depression.

THE condition of the heavy steel trade in Sheffield and district, especially on the basic side, shows no improvement. The majority of the furnaces are idle, and there is great difficulty in procuring work for those that are in operation. At Templeborough, five of the fourteen furnaces were restarted last week after the Easter stoppage. At the Ickles, only two or three were brought into commission. The position of the pig iron trade is equally unsatisfactory, but a gleam of hope comes from Lincolnshire. From that county last week I had to report that the Normanby Park Ironworks had found it expedient to put the whole of its men on notice, though it is not expected that that notice will be acted upon. Better news comes this week in the announcement that the North Lincolnshire Iron Company's works at Scunthorpe, which had been closed since September last, are to restart, and that two furnaces are to be put in blast. Stewarts and Lloyds, of Glasgow, who are associated with the North Lincolnshire Company, have booked some large orders. The acid side of the Sheffield steel trade is better situated than the basic, and is steadily though only moderately employed.

Armament Progress.

There is a great scarcity of armament and shipbuilding work, and a large part of the plant at the big East End works is idle. Some interesting developments in armaments, which have been carried out at the works of Hadfields, Ltd., were described by Sir Robert Hadfield at the annual meeting of the company last week. He stated that they had developed the latest type of armour-piercing shell of 16in. calibre, weighing practically a ton, for the British service. The first delivery of these shells, a short time ago, passed the official test and was accepted by the Government. Sir Robert was not, of course, at liberty to give any particulars of this test, but he did say that it was one of unexampled severity, which neither he nor the armament directors of the firm would have thought it possible to fulfil, only three or four years ago. The same firm has also achieved a notable success in the production of special thin armour. It obtained a contract in the face of competition from all the leading makers, its specimen plate having been found to be the best in the original trial test, and the result of the reception test was equally satisfactory, the whole of the armour being accepted without the rejection of a single pound. Sir Robert added that, while the line of work in question was not a particularly large one, still it was hoped that before long other contracts might come to the firm.

Various Steel Branches.

A fair amount of work continues to be booked by the sheet rolling mills, but short time is being worked at the rod mills. There is a brisk demand for cold rolled strip, but the trade is less active than it was last year. The position of the heavy and light forges is the reverse of satisfactory, only a few of them being fully occupied. On the lighter side, a fair amount of activity has to be reported in the tool-making departments. There is great competition for orders, and prices are severely cut in many instances. This is especially the case in files, and, as the work coming forward is not sufficient to keep all the firms employed, a good many of the smaller establishments are very quiet. There is a rather better demand for the best tool steels, but the trade remains on a small scale, while in ordinary crucible steels things are still quieter. A fairly good trade is being done in saws. The re-imposition of the McKenna duties is welcomed in Sheffield, chiefly from the point of view of the stimulus which it should give to the automobile industry. Several Sheffield plants do a large amount of work in the production of parts and special steel for motor cars.

Cutlery and Plate.

Both the cutlery and plate trades are still in an unsatisfactory condition. During the last few months some large orders have been received from shipowners and caterers, and a good deal of work is on hand in connection with the Wembley Exhibition, but the total output of cutlery, spoons and forks, and plate is a long way behind that of the corresponding period of last year. The small makers are comparatively better employed than many of the large works, but even they are finding it more difficult to provide employment for their hands. The trade in stainless steel table knives, which has enjoyed great activity for several years, began to fall off a few weeks ago, and its present proportions are much below those of last year.

Rapid Iron House Building.

A demonstration of the quick way in which cast iron houses can be built is afforded by the experimental pair of dwellings erected at Mortomley, near Chapeltown, by Newton, Chambers & Co., Ltd., the well-known coal and iron firm. The two houses have been put up in less than a week, and very little skilled labour has been required—they were, in fact, built in 32 working hours by one skilled man and four apprentices. In the words of one of the officials of the firm, "the houses can to all intents and purposes be built from stock, and, with the exception of certain parts, can be erected by apprentices." The outstanding principle employed is the use of standard cast iron plates of equal dimensions. These plates are roughcast before dispatch with a heavy layer of concrete of special composition, keyed in place by dovetail strips cast on to the plates. The plates are secured together by a patented joint, which also enables the internal walls to be fixed in position, and acts as a key for securing the doors and windows, a process which it is claimed will result in a more weather-tight finish than ordinary brick construction. The cost of the cast iron house is stated to be less than one of brick, while the upkeep should also be cheaper, as no re-pointing will be required. Neither should there be any continual expense in painting or covering with preservatives, as is the case with steel houses.

Colliery Matters.

This district is not suffering as much as some others from depression in the coal industry, but one or two stoppages of pits have been announced, and now the Staveley Coal and Iron Company is affected. In its case, it has been decided to close down the Dowell Colliery, a new pit which is in process of development, and is at present producing from 1300 to 1400 tons per week. The firm states that it has been unable to establish a standard of wages which would enable it to make ends meet, and that it cannot go on losing. It has, therefore, given notice to the men, who number about 600. The firm has also decided to stop the sinking of new shafts at its Markham and Warsop Collieries, as well as to stop a number of men at the Hartington pit. The agent explains that the colliery trade has grown so bad that the firm is compelled to economise. An item of colliery interest, relating to recent developments, is contained in the report of J. and G. Wells, Ltd., Eckington Collieries. They state that the installation of certain of the new plant at Norwood has been completed, and that the output of the pit is appreciably increasing; also that at the new pit at Westhorpe the Flockton seam is being opened out, and the development is proceeding satisfactorily.

Scarborough Valley Bridge.

Subject to the approval of the Ministry of Transport, the Scarborough Town Council has let the work of reconstructing the Valley Bridge to John Butler and Co., Ltd., of Stanningley Ironworks, Leeds. The net amount of the contract is £141,741, and, allowing for contingencies, £158,224. The Ministry is to make a grant of 65 per cent. The new bridge will consist of four spans of steel girder work on stone piers, and will provide a roadway 40ft. wide, with a 12ft. footpath on each side. The work is to be begun at once, and is expected to last about eighteen months or two years. In the first instance, half of the width of the new bridge will be built alongside the present structure. When that portion is ready for traffic, the existing bridge will be taken down and the remaining half of the new one will be completed.

Bridging the Ouse.

The long-standing project for building a new bridge over the river Ouse at Boothferry, near Goole, is being advanced this week. The Bill, which has been promoted by the West Riding County Council in co-operation with public authorities in the East Riding, is to come before the House of Lords Committee, and it is anticipated that there will be little opposition. The scheme is a very important one for improving the means of communication between the East and West Ridings, and it has the support of the Ministry of Transport, which is contributing 50 per cent. of the cost. Mr. Basil Mott, of Westminster, is the engineer, and his design provides for a swing span of 125ft. The total cost, inclusive of land, easements, parliamentary charges and general expenses, is estimated at £112,000, and the contract has been provisionally let to the Cleveland Bridge and Engineering Company, Darlington.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

ALTHOUGH the general position in the Cleveland pig iron trade is still very discouraging, there are some indications of improvement this week. The demand for iron still rules within very narrow limits, the slackness at the consuming foundries being most marked, but prices have been much steadier lately, and this fact has had the effect of giving a few buyers courage to operate. Thus there have been a few more sales of foundry iron, both in Scotland and the Continent, and a most gratifying feature is the negotiation of forward contracts. These contracts are for relatively small quantities, but after months of hand-to-mouth buying, the new turn of events indicates a growing confidence that bottom has been touched. Makers quote up to 77s. per ton for No. 3 G.M.B. Cleveland pig iron for export, but are selling for home consumption at as low as 76s. per ton. The reason for a distinction between home and export sales is not apparent, but as the difference favours the home buyer, there are no complaints on that score. No. 1 foundry is offered at 81s., No. 4 foundry stands at about 75s. 6d., and No. 4 forge at 74s. 6d. per ton.

Hematite Pig Iron.

There are now only ten blast-furnaces on the North-East Coast producing hematite pig iron, but still the output is in excess of the demand, and most of the makers have heavy stocks. There has been a little foreign inquiry this week, and sales have been put through on the basis of 81s. 6d. per ton for mixed numbers, and 82s. for No. 1.

Ironmaking Materials.

The foreign ore trade is lifeless, and best Rubio ore remains nominally at 22s. per ton c.i.f. Tees. There is no change in the coke market, good Durham furnace coke, varying from 22s. to 22s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

The position so far as the manufactured iron and steel trade is concerned shows practically no improvement, the only branch of which a better account is given being galvanised sheets, makers of which are very busy and report more work. Shipbuilders' requirements continue to dwindle, and a fair demand for light constructional and railway material does not compensate for a regular flow of specifications from the shipyards. Quotations are unsteady. Manufacturers declare that prices have sunk to levels that leave little or no margin of profit, and that any further fall must be speedily followed by the laying idle of more plant.

The Coal Trade.

The position in the Northern coal trade is still extremely disappointing. The market shows a quieter and easier tendency from last week, and while for prompt positions the pressure is sustained, new and forward deliveries show signs of slackening, and prospects are not so bright as they were a few days ago. The absence of forward business is causing considerable anxiety. All continental utility companies are holding off, and are only buying for weekly requirements, while all home works' needs are meagre. The output is limited to requirements, and could be readily increased to meet any special demands. There is little change in values, but the undertone is

easier. Best Northumberland steams are pressed on the market at 17s. 6d. per ton, but buyers hold off in hopes of securing discounts. There is a moderate movement for gas coals, and values show no change for any description. The latest ascertainments for wages in Northumberland and Durham show that in Northumberland there has been a slight increase, the new rate for the basis wages being 61.78 per cent., as against 61.36 per cent. in April. The minimum rate of wages payable in the county is 100 per cent., and thus the earnings payable this month will remain at slightly over 38 per cent. more than the proceeds and costs of the ascertainment would yield. In Durham there was a decrease of 1.95 per cent. during April. The minimum provides for 110 per cent., so that about 30 per cent. more than the economic state of the industry is required to meet the wages bill. The coke trade shows no revival in demand. Stocks of all makes are plentiful, and are held at easy values.

Iron and Steel Exports.

A discouraging feature of last month's trading in the iron and steel trade was a decline of approximately 20,000 tons in the exports of manufactured iron, pig iron and steel from the Cleveland district. In March the shipments totalled 98,001 tons, but in April they only reached 78,041 tons. Pig iron shipments declined from 35,915 tons to 30,635 tons, chiefly owing to smaller continental shipments. Germany was the largest foreign customer with 2364 tons, whilst France received 2187 tons, Italy 2245 tons, Belgium 1616 tons, and the United States 1550 tons. The coastwise shipments totalled 15,416 tons, of which 13,119 tons went to the East Coast of Scotland. The exports of manufactured iron and steel fell from 62,086 tons to 47,406 tons, the fall being largely accounted for by a drop in the shipments to India and Ceylon, which fell from 14,232 tons in March to 5880 tons in April.

Increased Imports.

The feature of the statistics presented at this week's meeting of the Tees Conservancy Commissioners, showing the imports of iron and steel to the Tees from continental countries, India and coastwise for the past six months, is the fact that they aggregated more than double the total for the corresponding pre-war period of 1913–14, and about 30,000 tons more than for the same period of 1923–24. The respective totals were :—1924–25, 88,469 tons ; 1923–24, 58,965 tons ; 1913–14, 37,700 tons. During the past six months the crude sheet bars, billets, blooms, slabs, &c., imported totalled 68,639 tons, as compared with 36,927 tons in 1923–24, and 24,134 tons in 1913–14. Pig iron imports reached 6891 tons, as against 13,707 tons for the corresponding period of last year and 106 tons in the pre-war period. The imports of plates, bars, angles, rails, sheets, joists, &c., totalled 12,939 tons, as compared with 8286 tons in 1923–24 and 13,460 tons in 1913–14.

Cleveland Miners' Wages.

The Cleveland ironstone mineowners have conceded advances varying from 1d. to 5d. per shift worked to the lower-paid men engaged at the mines. The men as a whole had claimed an increase in wages to enable them to meet the cost of living. The arrangement is of a temporary character, and is to continue in force until the wages revision in January, 1926.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding : Large Production, but Poor Prospects.

STATISTICS of launches during the month of April again present an almost wholly misleading appearance of prosperity at the shipyards. The returns are well above the average, and have only once been eclipsed within the last twenty-one years, and that was in April, 1913, when the launch of the Aquitania brought the figures to an exceptional total. The record for the year to date is larger by a few hundred tons than for the same period in the record year of 1913. The heavy returns for last month were, as in the month of March this year, largely made up by the launching of two liners. As these vessels are launched, however, the number of empty berths is added to, as practically nothing in the way of similar contracts are probable at present. There are now only three liners under construction in Clyde yards, and they will probably be completed before the end of the present year. Furthermore, contracts for general trading vessels become more scarce, and the orders announced during April fall far short of making good the work lost by launchings. The figures for April reached a total of twenty-four vessels of 94,046 tons aggregate, while for this year to date seventy-six vessels of 237,504 tons aggregate have been launched. Of the vessels put into the water, the chief were as follows :—Conte Biancamano, twin-screw, geared turbine, 22,000 tons, for the Lloyd Sabaudo Company, Genoa ; Caledonia, twin-screw turbine, 17,550 tons, for the Anchor Line ; Lumen, motor tanker, 9000 tons, for H. E. Moss and Co.'s Tankers, Ltd., Liverpool ; Maiden, geared turbine cargo steamer, 7730 tons, for T. and J. Brocklebank, Liverpool ; and the Florentino Ameglimo, oil tank steamer, 6900 tons, for the Argentine Government.

Steel.

Reports from steel works contain little of a fresh nature. The "freeing" of prices has perhaps brought out a number of inquiries, but the amount of new business has barely increased as yet. Prices depend on the class of specification and the tonnage, but as a rule the quotations named are lower than before the last meeting of the Association. Makers still experience difficulty in keeping mills employed, and do not anticipate an early improvement in business. Steel sheets under $^{3}/_{16}$in. to $\frac{1}{4}$in. are quoted £10 12s. 6d. per ton, but it is said that a lower figure would be accepted by some makers. The demand for galvanised sheets is about normal, but for plates and sections the inquiry has been too small to give any true indication of the tone of the market under the new conditions.

Iron.

Bar iron works are extremely quiet, the number of fresh orders being strictly limited. Re-rolled steel is in a similar position. The drop of 10s. per ton in bar iron has been of little avail so far, any orders coming forward being small in bulk. Comparatively cheap prices are being quoted for re-rolled steel, but it is doubtful if makers can quote a figure low enough to secure an order of respectable tonnage and still clear costs.

Pig Iron.

The pig iron market is weak. Home demands are poor, and while export may be regular, the tonnage is small. The tone is still inclined to further weakness.

Coal.

It is almost impossible to see anything of a promising nature in the coal trade. Home and export demands are decreasing, and the number of idle pits increases with every week that passes. Furthermore, idle time is prevalent at the pits still in operation. Despite the fall in output, the amount of fuel in wagons at the pit-heads is barely diminishing, owing to the difficulty of effecting sales, even when cheap terms are offered. Fife-shire and Lothians steams and treble nuts in both districts provide the exceptions to the general depression, and for these qualities shippers are disinclined to contract further than one week ahead. Aggregate shipments for the past week amounted to 257,787 tons, against 252,548 tons in the preceding week, and 231,007 tons in the same week last year. The home market is equally stagnant, industrial requirements being far from normal, while general utility concerns are taking minimum supplies.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE conditions in the steam coal trade remain very much about as they were last week, except that in the case of Admiralty qualities a slightly better tone prevails, and supplies of other descriptions are not so plentiful for prompt loading. This is in large part due to the suspension of work at the pits for the celebration of Labour Day. Some collieries were idle on Saturday in order that the workmen might demonstrate, while in other districts the men observed Monday as a holiday. This in the aggregate meant a fairly substantial loss of coal, and the consequence is that quite a number of salesmen have been unable to accept fresh orders for prompt loading and decline to take on any fresh obligations until next week. It is not a case of loading pressure at the docks suddenly becoming abnormal, because the reports show that there have been several loading appliances idle during the past week. Furthermore, the demand has not appreciably improved. A few inquiries have come along, but the requirements have not been on a heavy scale and, compared with normal conditions, the market can only be described as still depressing.

Coalfield Items.

May Day demonstrations passed off very quietly in this district. Nothing like the excitement usually occasioned when the leaders fire off their big guns prevailed on this occasion. Certainly a few of the leaders endeavoured to raise some enthusiasm among the workmen for the fight against the capitalisitic system, but it looks very much as if the demonstrations fell flat on the whole, and some of the meetings were very poorly attended. Since I wrote a week ago all the officials of the Ynysfaio Colliery at Treherbert have received notices terminating their employment, and the miners, numbering about 1400, received fourteen days' notices on Monday last. This colliery has been working very irregularly of late, and if work is suspended altogether it will be a severe blow to the Treherbert district. Hopes are, however, entertained that the notices will not take effect, but that the men will be able to continue work if only on the day to day principle. There was a prospect of work being brought to an end at the Bedwas Navigation Collieries for the reason that the property was not paying because of the restriction of output. The directors of the colliery placed the position before the local officials of the Miners' Federation and explained that unless the output was improved, the collieries would be closed. While no new proposals have been made or drastic changes introduced, the workmen's representatives have given an undertaking that every man would do his best to increase production and work is, therefore, continuing for the time being.

Dock Working Conditions.

The Cardiff District Committee of the Shipping Federation had before it last week two alternative schemes for the regulation of the coal trimming at South Wales ports. The author of the schemes is Mr. Stanley Hinde, of the firm of Messrs. W. E. Hinde and Co., who has closely studied the whole question and has endeavoured to find a remedy for the existing conditions, which are generally admitted to be unsatisfactory and in need of revision. It is generally considered that the work of shipment could be considerably speeded up if only the workmen would co-operate. The main point put forward by Mr. Hinde is that there should be work all round the clock, and that a third shift should be introduced. The exporters' views regarding the schemes are that they are framed rather too much in the interests of shipowners, while the verdict of the workmen's leaders is that the schemes are quite unacceptable as they entail a revival of the old gang system, when the employers had their own workmen, and there was no such institution as pooling of wages as at the present time. The men received in wages what they earned. However, it is hoped that when all the parties come together something will be hammered out of the proposals to bring about more satisfactory conditions at the docks.

Good Order for Tubes.

Considerable satisfaction is felt in this district at the success which has attended the efforts of the British Mannesmann Tube Company, of Newport and Swansea, and Stewarts and Lloyds, Ltd., of Glasgow, in securing the contract for £100,000 for tubes for the Anglo-Persian Oil Company. The latter was naturally anxious that the order should not go out of the country, and, as the result of a conference between the parties, the price difficulty was overcome by co-operation instead of the companies quoting sepatately and losing the order to Germany. The bulk of the work, it is understood, will be carried out by the British Mannesmann Company at its Newport works, and it will entail the employment of additional workmen.

Tin-plate Bombshell.

A very important development affecting the Welsh tin-plate trade took place last week. It concerns the continuance of the stabilisation scheme. It is only a few weeks ago that the Committee decided to continue the scheme until October 19th, with a suggestion that a revision should take place some weeks prior to that date. However, it is understood that, recently, tin-plates have been sold below the official minimum of 22s. 1½d. per standard box, and on Friday last works proprietors received a communication from the chairman of the Stabilisation Committee stating, in effect, that in view of the underselling the stabilisation scheme would be brought to an end. A meeting of the Committee was called for the early part of this week to consider the whole position. The scheme was brought into operation towards the end of 1922, and has no doubt been largely successful in meeting the depressed conditions which have prevailed during the period. Since the announcement of the break-up of the scheme leaving firms free to quote, prices have fallen considerably below the minimum, as on Monday plates were being dealt in at 21s. per box as against 22s. 1½d. One of the greatest dangers apprehended as the result of the development is the prospect of the importation of foreign bars, which will severely affect the local steel trade.

LATER.

A meeting of tin-plate manufacturers and Siemens steel manufacturers of South Wales was held on Tuesday, when the position arising from the break-up of the stabilisation of prices scheme was considered. No official statement was issued, but it is understood that, while the stabilisation scheme is terminated and a free market for tin-plates now exists, hopes are entertained that part of the scheme, such as pooling of orders, may be retained.

Ship Repairing.

The ship repairing industry in South Wales continues very quiet, but the Penarth Pontoon and Ship Repairing Company, Ltd., has secured in open competition a contract for extensive repairs to four vessels belonging to the Great Western Railway Company. This will provide the company with employment for quite a considerable time.

Cardiff Shipping Company's Affairs.

Many shipping undertakings formed during the war time and since then have been unable to meet the strain of depreciated values and deflation, and general regret is felt in this district at the development this week regarding the Gould Steamships and Industrials, Ltd., the offices of which are at Merthyr House, Cardiff, an order for the appointment of a receiver and manager being made by Mr. Justice Eve on Tuesday. Efforts were made up to the last minute almost to avert this development, which was not altogether unexpected, but the negotiations to save the company broke down.

Current Business.

Operations on the steam coal market have been on a somewhat limited scale during the past week, but the tone has been a shade steadier for prompt supplies of coal on account of the diminished output. Admiralty large coals have been relatively better than other descriptions, and have in some cases commanded 3d. more than was the case last week. This improvement is regarded as only temporary, as the foreign demand has not appreciably expanded, and competition continues to be exceptionally keen. Anthracite coals maintain firmness, with the exception of duff coals, which are plentiful.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—The annual smoking concert of the Faraday House Old Students' Association was held at the Hotel Cecil (Princes Hall) on May 1st, Mr. H. W. H. Richards, M.I.M.E. (F.H. 1905–09), the president of the Association, being in the chair. There was a large attendance, and the excellent programme of music was much appreciated. Mr. H. W. Swann (F.H. 1902–3), H.M. Electrical Inspector of Factories, proposed a vote of thanks to the chairman, which was enthusiastically carried.

THE INSTITUTION OF CIVIL ENGINEERS.—The Council of the Institution of Civil Engineers has recently made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1924–1925 :—A Telford Gold Medal to Mr. Donald Paterson, M. Inst. C.E. (Johore Bahru) ; a Watt Gold Medal to Dr. E. H. Salmon, M. Inst. C.E. (London) ; a George Stephenson Gold Medal to Mr. L. H. Savile, M. Inst. C.E. (London) ; Telford Premiums to Mr. G. Mitchell, M. Inst. C.E. (Aberdeen) ; Dr. T. E. Stanton, F.R.S. (Teddington) ; and Mr. F. E. Wentworth-Sheilds, M. Inst. C.E. (Southampton) ; a Crampton Prize to Professor A. H. Gibson, D.Sc., M. Inst. C.E. (Manchester) ; and a Manby Premium to Mr. P. W. Robson, M. Inst. C.E. (Lincoln).

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	20/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 10 6	—
No. 1 Foundry	4 10 0	—
No. 3 Foundry	4 7 6	—
N.E. COAST—		
Hematite Mixed Nos.	4 1 6	4 1 6
No. 1	4 1 0	4 1 0
Cleveland—		
No. 1	4 1 0	4 1 0
Silicious Iron	4 1 0	4 1 0
No. 3 G.M.B.	3 16 0	3 16 0
No. 4 Foundry	3 15 0	3 15 0
No. 4 Forge	3 14 [illegible]	3 14 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 10 0 to 3 12 6	
,, Forge	3 6 0 to 3 7 0	
(3) Derbyshire—		
No. 3 Foundry	3 15 0 to 3 17 0	
Forge	3 12 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 0 0	—
No. 4 Forge	3 15 0	—
Basic	3 15 0	—
(4) N.W. COAST— N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 13 0 (a); 4 16 0 (b); 5 1 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 12 6	—
Best ,,	—	—
N.E. COAST—		
Common Bars	11 12 6	—
LANCS.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 10 0	—
Ship Plates, ¾in. and up	8 17 6	—
Sections	8 7 6	—
Steel Sheets, under 3/16in. to ¼in.	10 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 17 6	—
Angles	8 12 6	—
Boiler Plates	13 0 0	—
Joists	8 12 6	—
Heavy Rails	9 0 0	—
Fish-plates	13 10 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 15 0†	—
Light ,,	9 0 0 to 9 5 0	
Billets	8 0 0 to 11 0 0†	
MANCHESTER—		
Bars (Round)	9 0 0 to 10 0 0	
,, (others)	8 15 0 to 9 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 5 0	—
,, (Lancs. Boiler)	12 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
MIDLANDS—		
Small Rolled Bars	8 15 0 to 9 15 0	
Billets and Sheet-bars	6 17 6 to 7 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	8 10 0 to 8 15 0	
Joists	8 10 0 to 8 13 0	
Tees	9 10 0 to 9 15 0	
Bridge and Tank Plates	9 10 0	—
Boiler Plates	13 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/10½ to 21/3
Block Tin (cash)	241 5 0
,, (three months)	244 0 0
Copper (cash)	60 5 0
,, (three months)	61 5 0
Spanish Lead (cash)	32 10 0
,, (three months)	32 0 0
Spelter (cash)	34 3 9
,, (three months)	33 2 6
MANCHESTER—	
Copper, Best Selected Ingots	64 10 0
,, Electrolytic	65 10 0
,, Strong Sheets	‡91 0 0
,, Tubes (Basis Price)	‡ 0 1 1
Brass Tubes (Basis price)	‡ 0 0 11½
,, Condenser	‡ 0 1 2
Lead, English	35 0 0
,, Foreign	33 15 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 5 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£43 0 0	15/6
,, ,, 1 p.c. ,,	£32 0 0	17/-
,, ,, 0.70 p.c. carbon	£57 10 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 15 0 unit	scale 5/- per
,, ,, 75 p.c.	£22 0 0 unit	scale 6/- per
,, Vanadium	17/- per lb	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/- per lb	
Nickel (per ton)	£175	
Cobalt	10/3 per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	15/3
,, ,, Ell	16/-
,, ,, Splint	17/ to 19/3
,, ,, Trebles	14/6
,, ,, Doubles	13/9
,, ,, Singles	13/3
AYRSHIRE—	
(f.o.b. Ports)—Steam	15/3
,, ,, Splints	17/-
,, ,, Trebles	14/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	14/- to 16/-
Screened Navigation	21/9
Trebles	16/-
Doubles	13/3
Singles	13/
LOTHIANS—	
(f.o.b. Leith)—Best Steam	15/10½
Secondary Steam	15/1½
Trebles	16/3
Doubles	13/6
Singles	13/-

ENGLAND.

	Inland.
(8) N.W. COAST—	
Steams	27/-
Household	45/- to 58/4
Coke	28/-
NORTHUMBERLAND—	
Best Steams	17/3 to 17/6
Second Steams	16/6
Steam Smalls	11/- to 11/6
Unscreened	15/6 to 16/6
Household	23/6 to 25/-
DURHAM—	
Best Gas	19/6 to 19/9
Second	17/- to 17/3
Household	23/6 to 25/-
Foundry Coke	21/6 to 22/6
SHEFFIELD—	Inland.
Best Hand-picked Branch	30/- to 33/- —
Barnsley Best Silkstone	26/- to 27/- —
Derbyshire Best Brights	26/- to 28/6 —
,, ,, House	23/6 to 25/6 —
,, ,, Large Nuts	18/- to 22/- —
,, ,, Small	14/- to 16/- —
Yorkshire Hards	18/- to 22/- —
Derbyshire ,,	18/6 to 22/- —
Rough Slacks	10/- to 12/6 —
Nutty ,,	8/6 to 10/- —
Smalls	3/6 to 5/6 —
Blast-furnace Coke (Inland)*	— —
,, ,, (Export)	f.o.b. 21/3 to 22/3

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	26/- to 26/6
Second ,, ,,	25/3 to 26/-
Best Dry Large	25/- to 25/6
Ordinary Dry Large	23/6 to 24/6
Best Black Vein Large	24/6 to 25/-
Western Valley ,,	23/6 to 24/6
Best Eastern Valley Large	23/- to 24/-
Ordinary ,, ,,	22/6 to 23/-
Best Steam Smalls	15/6 to 16/-
Ordinary ,,	13/- to 15/-
Washed Nuts	20/- to 28/-
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	17/- to 18/-
No. 2 ,, Large	22/- to 23/-
,, ,, Through	18/- to 20/-
,, ,, Smalls	12/- to 13/6
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	25/- to 30/-
Patent Fuel	23/- to 26/-
Pitwood (ex ship)	23/6 to 24/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	44/- to 46/-
Seconds	38/- to 40/-
Red Vein	29/- to 32/-
Machine-made Cobbles	52/6 to 57/6
Nuts	50/- to 55/-
Beans	37/6 to 41/6
Peas	22/6 to 23/6
Breaker Duff	8/6 to 8/9
Rubbly Culm	13/- to 13/3
Steam Coals:	
Large	21/- to 24/-
Seconds	20/- to 21/-
Smalls	10/- to 13/-
Cargo Through	16/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/9, with fluctuations according to analysis; open market, 18/- to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow, (b) Delivered Sheffield, (c) Delivered Birmingham.

‡ A reduction may come this week.

French Engineering Notes.

(From our Correspondent in Paris.)

Liquefying Coal.

ONE of the factors tending to restrict the importation of coal is the progress being made with the utilisation of cheap native fuels. The use of pulverised coal has already given great value to the immense quantities of slack that formerly accumulated at the pits, and the considerable reserves of poor quality fuel which did not pay for the working will find employment through the development of the low carbonisation process. Dr. Bergius now affirms that the method of liquefying coal has made so much headway that it may be regarded as an industrial success. In that event there is a prospect of the colliery industry starting upon a new phase of development, which will eventually change entirely the conditions of the coal trade. The problem is of particular interest to the French, who hope to derive a large proportion of their motor spirit from the reserves of poor quality coal. Obviously, the successful utilisation of liquid fuels from coal depends upon the cost, and the problem is apparently in much the same stage as the production of synthetic petrol from vegetable oils, which has so far failed of practical realisation, although figures showing the probable prime cost are brought forward to prove that it is industrially sound.

The Charcoal Congress.

The demonstrations of suction gas vehicles employing charcoal as a fuel, which were recently held at Blois, aroused a good deal of interest, and the Congress on charcoal was well attended by specialists and others, several of whom contributed papers upon the methods to be adopted for increasing the production of charcoal and utilising it in the place of imported oils for internal-combustion engines. If the production is to be increased sufficiently for the purpose it can only be done with the aid of portable carbonising plants. Tests of such plants are now being carried out, but it does not appear as if the portable installations entirely fulfil the conditions required, for it is evident that if charcoal is to become a national fuel, it must be produced abundantly and cheaply. So far, the effect of a comparatively small increased consumption has been to inflate the price of charcoal to a figure which threatens to keep its employment within very narrow limits. There seems to be little hope of the propaganda in favour of charcoal giving appreciable results unless users are assured of obtaining cheap and ample supplies. Nevertheless, the Congress at Blois seemed to be of the opinion that motor vehicles did not, for the present, offer a sufficient opening for the fuel. This was the most difficult application, and it would probably take a long time before charcoal could come into extensive use for motor vehicles. The Congress, therefore, turned its attention more particularly to industrial engines, and suggested that there was an enormous scope for the fuel in the 600,000 internal-combustion engines employed in this country. It was proposed that specially low railway rates should be applied to charcoal, and that petrol engines running on suction gas produced from that fuel should be taxed at 25 per cent. less to compensate for the lower efficiency. Many attempts are being made to employ charcoal in suction gas plants for motor vehicles and portable and fixed engines, but the problem is obviously being tackled from the wrong end, and users must have the assurance that the price of charcoal will not continue to advance at a rate out of all proportion to the increased consumption.

The Alsace Canal.

The conflict between the French Government and the Swiss authorities over the construction of the Alsace Canal has been settled by a decision of the Commission Centrale du Rhin, which aims at giving satisfaction to both parties. By the Treaty of Versailles the French were authorised to construct the lateral canal on condition that the Commission, representing the countries interested, was of the opinion that it would not have a prejudicial effect upon the river. The French were particularly desirous of carrying out this work for the sake of the 785,000 horse-power which would be produced by the hydro-electric plants to be laid down on the seven sections of the canal. It would also have the further advantage of completing the uninterrupted waterway from the Rhine to Marseilles, whereby it was hoped to divert traffic from Central Europe to the Mediterranean port. The Swiss and the Germans vigorously opposed the scheme on the ground that its construction would occupy too long a time, and they presented an alternative proposal for deepening the Rhine by the creation of artificial banks, in much the same way as has been done on the Loire and elsewhere. The Swiss Government nevertheless sanctioned the construction of the first section of the canal from the frontier to Kembs as a means of avoiding the Istein rocks, which are a serious obstacle to navigation. The German opposition has been particularly strong, and the German delegates refused to take part in the voting of the Commission, which declared that the French Government was entitled to construct the Alsace Canal under certain conditions, and that the Swiss Government was authorised to deepen the Rhine between Strasburg and Basle. It is understood that the French have decided to start upon the construction of the canal immediately it is sanctioned by Parliament.

Road Paving.

In consequence of the increasing traffic the problem of road maintenance in Paris offers as many difficulties as in other cities, and the cost of keeping the roads in good repair has been growing so rapidly that everything possible is being tried to obtain the most satisfactory and most economical results. During the present year a sum of 5,868,000 f. is to be spent upon the paving of roads with stone setts, 2,910,000 f. upon asphalt and 2,688,000 f. on wood pavement. Experiments carried out with concrete during the past year have so far given doubtful results, and tests are now to be made with a kind of bituminous concrete and also with hard teak blocks. For the first time most of the work will be given out under maintenance contracts. This will be done in the case of all the wood pavement, of which 166,000 square metres will be laid down during the present year.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

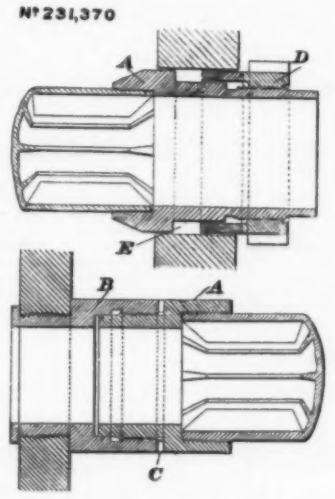
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

231,370. July 16th, 1924.—MOUNTING SMOKE TUBES IN BOILERS, Les Fils de Jules Weitz, 111, Chemin des Culattes, Lyons, France, and C. P. Altmann, St. Didie-au-Mont d'Or.

The object of this invention is to facilitate the renewal of smoke tubes in boilers. The tubes are consequently fitted with end pieces A A, which are secured by screwing and brazing.

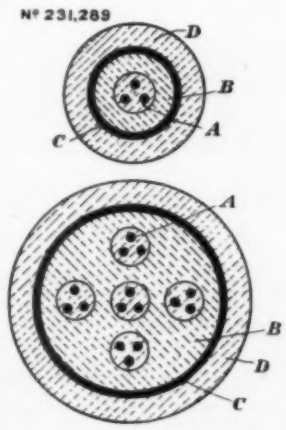


At the fire-box end, on the left of the drawing, the end piece is screwed into a socket B, and is made tight with a soft metallic washer C. At the smoke-box end a ferrule D is screwed on to the end piece, and is used to compress a packing in the space E, to make a tight joint. It will be observed that a new tube can be put in place through the smoke-box tube plate; but the tube has no staying effect.—*April 2nd*, 1925.

TRANSMISSION OF POWER.

231,289. February 15th, 1924.—IMPROVEMENTS IN ELECTRIC CONDUCTORS, St. Helens Cable and Rubber Company, Ltd., of Trading Estate, Slough, and John Henry Chilcote Brooking, of the Milestone, Bath-road, Slough.

This invention relates more particularly to that type of cable in which a single or multiple insulated conductor core is protected by a continuous metallic sheathing. It has been found that under certain conditions of dampness of ground, metal-sheathed or armoured cables are affected by stray electrical currents, and attempts to bond the sheathing or armouring throughout its length are not always practicable or successful. According to this invention, a single insulated conductor core or a multiple insulated conductor core electric cable, having a metallic sheathing or armouring, has applied to it on the outside of the sheathing or armouring a covering of tough rubber, which serves the dual purpose of forming a waterproof cover to prevent the sheathing being corroded, and of providing a

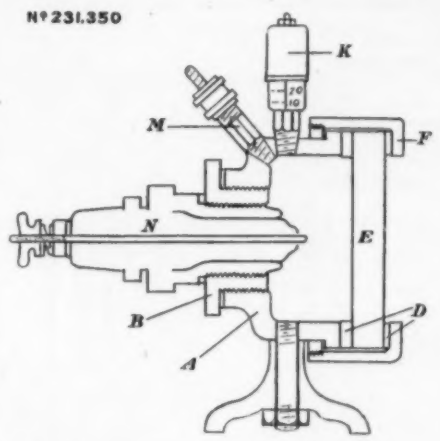


sufficiently durable covering for the cable against mechanical damage. The lead covering prevents moisture getting through to the hygroscopic insulation. The steel tape armouring consists of thick wide layers of steel strip, wound round the electric cable in order to prevent it being damaged when laid direct in the ground, and the same applies to cables armoured with galvanised steel wires. Steel wires are usually of a large section, namely, one-tenth of an inch diameter, and are stranded round the cable in order to give it mechanical protection. Submarine cables, for instance, are armoured in this manner. The invention provides for a covering of tough rubber over this metallic armouring, in order to prevent it being corroded. Two forms of conductor are shown by way of example in the accompanying drawings. A is a conductor, B a normal insulation, C a lead sheathing or the similar metallic sheathing or armouring, whilst D is a covering of tough rubber or what is known in the trade as "cab tire" rubber. A suitable mix for this rubber is—30 lb. raw rubber, 8 oz. sulphur, 8 oz. accelerator, 10 lb. carbon gas black, 2 lb. M.R.X., and 7 lb. asbestine. The armouring C may be either steel wires or a one-piece lead sheathing.—*April 2nd*, 1925.

MEASURING AND TESTING INSTRUMENTS.

231,350.—May 31st, 1924.—AN IMPROVED APPLIANCE FOR TESTING ELECTRICAL ENERGY AND SPARKING PLUGS UNDER PRESSURE, Frank Ball, of 4, Market-place, Buxton.

With the aid of the apparatus described in this specification, the inventor claims that certain drawbacks associated with the usual apparatus for testing sparking plugs under pressure are eliminated, and that a number of plugs of different makes can be tested at the same time. Referring to the drawing, A is a metal cylinder at one end of which is a screwed aperture, suitable for the reception of a sparking plug, or an "adapter" B, into which, in turn, screws the sparking plug N, as shown. At the other end of the chamber is a glass disc or lens E, held in position by a clamping ring F and flexible packing rings D. After fixing the sparking plug N, air under pressure is admitted to the

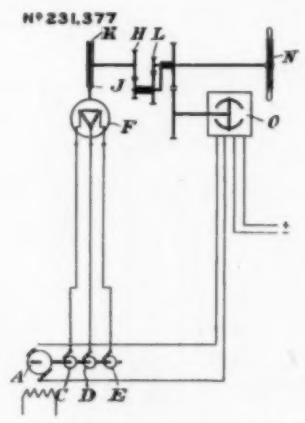


interior of the cylinder through the air valve M. A pressure gauge K is provided to indicate the pressure of the air in the test chamber. When the plug to be tested has been connected to the magneto and the cylinder connected by a suitable lead to "earth," the test can proceed in the usual way. Owing to the relatively large diameter of the window and the wide angle of observation thereby provided, any leakage of current behind the main spark can be readily detected, and, owing to the sparking plug being coaxial with the cylinder and the points close to the window, the main spark can easily be seen. A safety valve and a blow-off tap may be provided, and a magnifying glass may be used in place of the plain glass E. By the use of the interchangeable "adapter," sparking plugs with screw threads of different pitch can be used with the one apparatus.—*April 2nd*, 1925.

SHIPS AND BOATS.

231,377. July 26th, 1924.—IMPROVEMENTS IN OR RELATING TO ELECTRIC STEERING APPARATUS, Siemens-Schuckertwerke Gesellschaft mit beschränkter Haftung, of Siemensstadt, near Berlin.

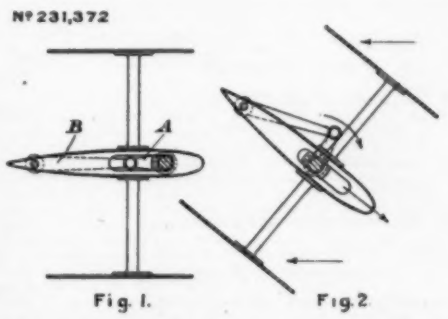
The steering motor A is provided with three slip rings C, D and E, which supply three-phase current to the synchronous motor F, which drives one side of the differential gear H by



means of the worm J and the worm wheel K, while the other side L of the differential gear is moved by the steering wheel N. The difference of the two movements is utilised for switching the reversing starter O for the steering motor. The approximate synchronous transmission of movement between the steering motor and the differential gear ensures that a given travel of the rudder will always correspond to an approximate given number of revolutions of the steering wheel.—*April 2nd*, 1925.

231,372. July 21st, 1924.—BALANCE RUDDERS, E. Kirtelsen and Lloyd Propulsion, Ltd., Eidsvolkverk, Eidsvolk (Akershus), Norway.

The blade of this balanced rudder is moved, with respect to



its shaft, so that the pressure centre is always at the axis of the shaft and torque on the shaft is consequently minimised. The drawing shows a rudder with three blades connected together.

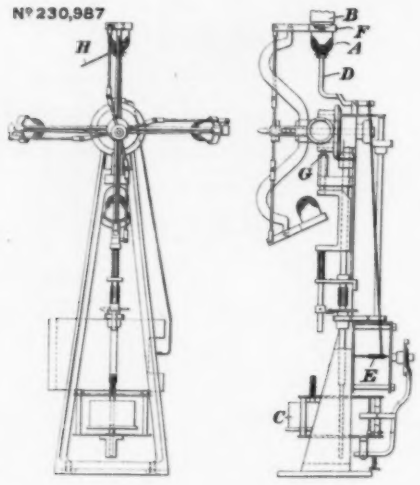
The centre blade is slotted, as shown, for the reception of the shaft, and is connected therewith by the cranks A and links B. The result is that when the rudder is given helm, as shown in Fig. 2, it is simultaneously moved forward on its shaft.—*April 2nd*, 1925.

LIGHTING AND HEATING.

230,987. March 12th, 1924.—EXCHANGING INCANDESCENT MANTLES AUTOMATICALLY, Chance Brothers and Co., Smethwick, A. H. Alexander, Hurstleigh, Buckhurst-hill, Essex, and M. C. Ritchie, 145, Farringdon-road, London, E.C. 1.

This mechanism is intended for automatically replacing incandescent mantles of navigation lights when they are broken. The active mantle is shown at A, under the burner B. Three other mantles are provided on the arms of a star, which can be

Nº 230,987



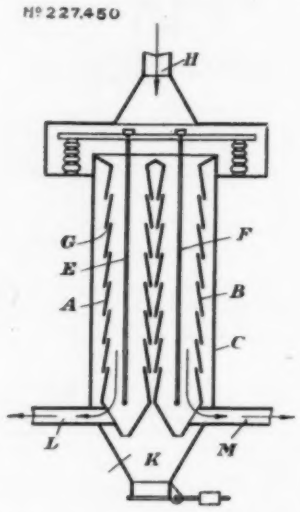
rotated by clockwork C. Beneath the mantle in use there is a button of refractory material on a lever D. When the mantle breaks, this lever rises and releases the clockwork E, which, in turn, releases the main clockwork C. The frame F carrying the broken mantle is then moved clear of the burner, the locking bolt G is opened, and the next mantle is swung into position. In doing so it slides over the guard H and depresses the lever D again, so that the clockwork is stopped when the new mantle is in position.—*March 26th*, 1925.

MISCELLANEOUS.

227,450. January 7th, 1925.—IMPROVEMENTS IN OR RELATING TO ELECTRIC GAS-PURIFYING PLANTS, Siemens-Schuckert-werke Gesellschaft mit beschränkter Haftung, of Siemens-stadt, near Berlin.

According to this invention, two pipes A and B are placed in a large chamber C, and for the production of the electric discharge two electrodes E and F are provided. Slots G are formed in the pipes A and B. The gas to be purified passes through the supply

Nº 227,450

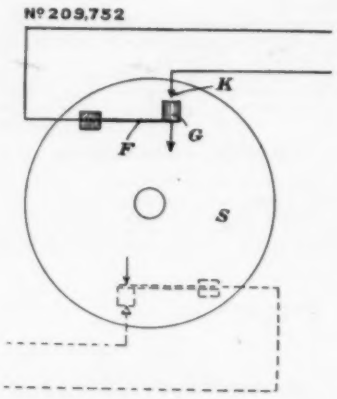


pipe H into the pipes A and B, and owing to the action of the discharge electrodes the particles of dust are driven downwards. On account of the action of gravity, but more particularly under the influence of the gas current, they pass through the slot openings G into the space between the precipitation pipes and the wall of the box, and fall into the collecting funnel K, whilst the purified gas leaves the plant by way of the two escape pipes L and M. There are three other illustrations.—*April 2nd*, 1925.

209,752. January 10th, 1924.—SPEED REGULATOR FOR MAINTAINING PRIME MOVERS AND MORE PARTICULARLY HIGH-SPEED MACHINES, Lorenz Aktiengesellschaft, of Lorenzweg, Berlin-Tempelhof, Germany.

This invention relates to a speed regulator for maintaining prime movers, and more particularly high-frequency machines, at a constant speed, and the inventor's object is to provide a regulator which will allow the output or speed to be maintained constant within less than $^1/_{100}$ per cent. A spring F loaded with a weight G at a suitable point is mounted near the periphery of a rotating disc S. The weight is placed at the point on the spring where the amplitude of oscillation of the latter is a maximum, and the weight acts as a contact that co-operates with the contact K. When the disc S runs at such a speed that the electrical circuit, which is indicated in the drawing, is closed through the contacts G K, the circuit is continuously closed and interrupted in such a manner that its closing and opening will be effected during each revolution of the disc, and the contacts will be closed for a longer or shorter time, according to the tendency of the speed to increase or decrease. In the position shown in the full lines, the circuit will be open, and in the position indicated in dotted lines it will be closed, as in the latter case the centrifugal force is assisted by gravity—the weight of the spring minus the centrifugal force of the latter. The device is said to be very suitable for the speed regulation of continuous-

Nº 209,752

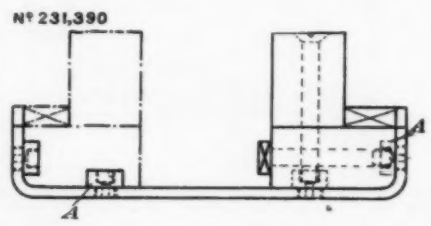


current motors, in which the magnetic field has to be varied gradually and in which the action of self-induction has to be overcome.—*April 2nd*, 1925.

231,390. October 7th, 1924.—BOLTING WOOD TO THIN IRON PARTS, Cristoph and Unmack Aktiengesellschaft, 7, Gartenstrasse, Niesky, Oberlandsitz, Germany.

This invention relates to the construction of compound, or flitch, frames for motor vehicles, tramcars, &c., and is concerned with the connection between the thin metal part and the woodwork. In order to overcome the difficulty, commonly experienced when countersunk wood screws are used, of the heads becoming

Nº 231,390



conspicuous after service, bosses A A are welded to the back of the plate and are screwed to receive bolts reaching right through the woodwork. The difficulty of drilling the wood in register with the bosses on the plate is overcome by providing a small hole right through the boss. This hole enables a pilot drill to be run through from the front, and the hole in the wood is subsequently enlarged. The small holes are soldered up when the job is complete.—*April 2nd*, 1925.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

English Mechanics and World of Science requests that all communications should now be sent to its new office at 2, Breams-buildings, Chancery-lane, London, E.C. 4.

WE are asked to state that Mr. Herbert C. Siddeley has been appointed the London and export sales manager of the National Gas Engine Company, Ltd., succeeding Mr. C. P. King, who has retired after many years' service with the company.

JOHN LYSAGHT, Ltd., of Bristol and Newport, Mon., asks us to announce that the address of its London office has now been changed from 36, Gracechurch-street, to 66, Cannon-street, E.C. 4. Telephone, City 5721; telegrams, Lysaght, Cannon, London.

WE are asked to state that the business of Light Steelwork, Ltd. (in voluntary liquidation), has been acquired by Mr. J. Chas. Moore, late manager and director, and that a new company, entitled Light Steelwork (1925), Ltd., of which he will be managing director, is in process of formation. The offices will be transferred from 178, York-road, N. 1, to 25, Station-road, Harlesden, N.W. 10 (close to Willesden Junction Station), as from May 11th.

CONTRACTS.

SHELL-MEX, Ltd., asks us to announce that Shell spirit has been chosen for the new air mail service from Capetown to Durban, and that the lubricating oil supplied to his Majesty's yacht, the Victoria and Albert, at Genoa, was Shell "All's Well" marine engine oil.

VICKERS LTD. announce that they have received an order from the Salt Union, Ltd., Winsford, Cheshire, for a sectional pontoon type of floating dock capable of lifting small vessels up to 300 tons displacement. The dock is to be erected in an arm of the river Weaver, near Winsford.

HOWDEN-LJUNGSTROM PREHEATERS (LAND), Ltd., of Glasgow, has received an order to supply one preheater to S. Fielding and Co., Ltd., Devon Pottery, Stoke-on-Trent. The total heating surface of the preheater is to be 5100 square feet; air will be supplied to the furnace at about 510 deg. Fah.

IN connection with its £14,000,000 renewals scheme, contracts have been placed by the London, Midland and Scottish Railway for new rolling stock, for use on the Cathcart service (Glasgow), with R. Y. Pickering and Co., Ltd., of Wishaw, and Hurst, Nelson and Co., Ltd., of Motherwell.

THE UNDERFEED STOKER COMPANY, of Aldwych House, Aldwych, London, W.C. 2, has recently received the following orders:—For sixty-two travelling grates from seventeen customers; for seven underfeed stokers; for two air heaters; for ash conveyors from four customers; for two soda grates; for a pulverised fuel plant; and for suspended arches from eight customers.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF AERONAUTICAL ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Lessons of 1924," by Captain W. H. Sayers. 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate Westminster, London, S.W. 1. Fourth Report of the Steam Nozzles Research Committee. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Wales District meeting. 1.30 p.m.

IRON AND STEEL INSTITUTE.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Annual meeting. For programme, see page 411. 10 a.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, London, S.W. 7. Papers: "A Magnetic Bridge for Testing Straight Specimens and an Analysis of the Hysteresis Loop of Cobalt Chrome Steel," by Mr. E. Hughes; "The Experimental Control of Electrically Broadened Spectral Lines," by Mr. M. C. Johnson; "On the Spectra of the Metals of the Aluminium Sub-group," by Mr. M. K. Rao. Demonstration, "The Diffraction of Light by a Spherical Obstacle," by Professor A. O. Rankine. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Circulation of Blood in the Capillary Vessels," by Dr. H. H. Dale. 9 p.m.

SATURDAY, MAY 9TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Eastern District meeting at Worthing. 11.15 a.m.

MONDAY, MAY 11TH.

WOMEN'S ENGINEERING SOCIETY.—Visit to the motor works of Clement-Talbot, Ltd. 3 p.m.

TUESDAY, MAY 12TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Annual general meeting of corporate members only. 6 p.m.

FRIDAY, MAY 15TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Recent Developments in Magnetism," by Professor C. G. Darwin. 9 p.m.

WEST BROMWICH ENGINEERING SOCIETY: RADIO SECTION.—The Technical School, West Bromwich. Lecture, "Radio Valves," by Mr. R. C. Clinker. 7.30 p.m.

FRIDAY AND SATURDAY, MAY 15TH AND 16TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Irish District meeting at Dublin.

SATURDAY, MAY 16TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit to the works of Leyland Motors, Ltd., Leyland, near Preston. 3 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Western District meeting at Tiverton. 11 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Wath-upon-Dearne. Yorkshire District meeting. 10 a.m.

TUESDAY, MAY 19TH.

ILLUMINATING ENGINEERING SOCIETY.—Lighting Service Bureau, 15, Savoy-street, Strand, London, W.C. 2. Paper, "A Survey of Lighting in 800 Retail Shops," by Messrs. W. J. Jones and H. Lingard. 7 p.m.

WEDNESDAY, MAY 20TH.

INSTITUTION OF PRODUCTION ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Mechanical Costing," by Mr. S. C. Downes. 7.30 p.m.

FRIDAY, MAY 22ND.

DIESEL ENGINE USERS' ASSOCIATION.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Pyrometry of Exhaust Temperatures of Internal Combustion Engines," by Mr. Charles E. Foster. 3.30 p.m.

ROYAL INSTITUTION.—The annual meeting of the members of the Royal Institution was held on Friday afternoon, May 1st, Sir James Crichton-Browne, Treasurer and Vice-president, in the chair. The annual report of the Committee of Visitors for the year 1924, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The report of the Davy Faraday Research Laboratory Committee was also read. Seventy-eight new members were elected in 1924, and sixty-three lectures and nineteen evening discourses were delivered. The books and pamphlets presented amounted to about 273 volumes, making, with 678 volumes (including periodicals bound) purchased by the Managers, a total of 951 volumes added to the library in the year. Thanks were voted to the president, treasurer and secretary, to the Committees of Managers and Visitors, and to the professors for their valuable services to the Institution during the past year. The following were unanimously elected as officers for the ensuing year:—President, the Duke of Northumberland; treasurer, Sir James Crichton-Browne; secretary, Sir Arthur Keith; Managers, Sir Thomas Barlow, Sir John Biles, Sidney G. Brown, Ernest Clarke, Sir Dugald Clerk, Professor J. A. Fleming, Earl Iveagh, Sir George Lawson Johnston, Sir Oliver Lodge, Charles H. Merz, Sir Ernest Moon, the Hon. Sir Charles Parsons, Sir Edward Pollock, Sir Robert Robertson, and Sir Almroth Wright; Visitors, K. A. Wolfe Barry, Alfred Carpmael, Edward Dent, William H. Eccles, Viscount Falmouth, Frederick H. Glew, W. E. Lawson Johnston, Alexander G. Low, Ronald Malcolm, Clifford C. Paterson, Sir Walter Peacock, Herbert M. Phipson, Hugh Munro Ross, Frank Coston Taylor, and John Tennant.